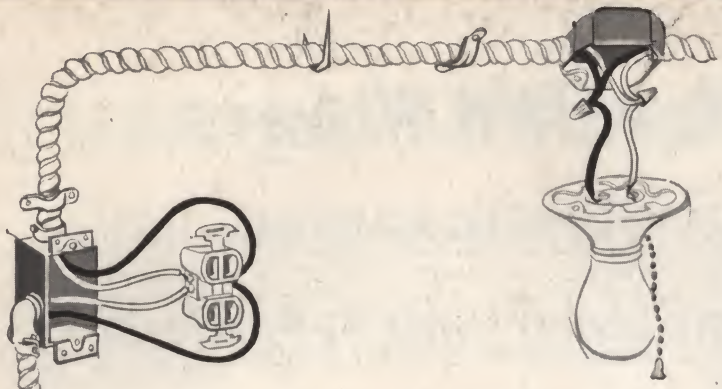

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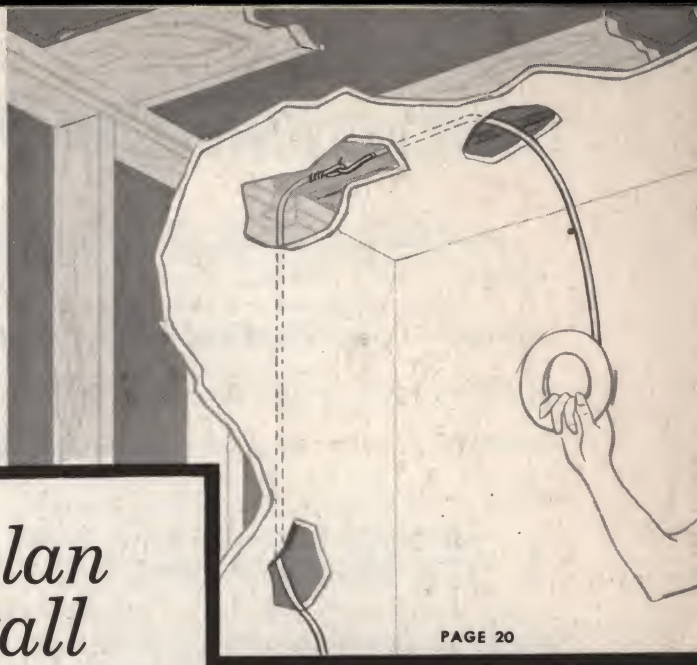

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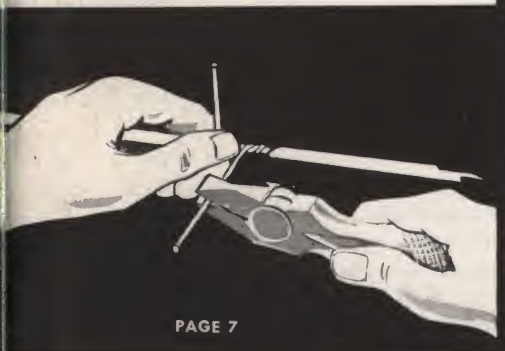


PAGE 7

how to plan and install

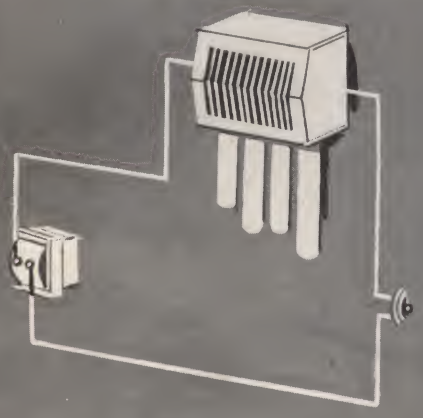
ELECTRIC WIRING

for

HOMES ····· FARMS
GARAGES ····· SHOPS

MONTGOMERY WARD

PAGE 10



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new edition

OVER 100 ILLUSTRATIONS

83–850

YOU Can Do Your OWN Wiring

- SAVE LABOR COSTS—DO ELECTRIC WORK YOURSELF
- WARDS HAS COMPLETE LINE OF WIRING MATERIALS
- ONLY BASIC WORKSHOP TOOLS NEEDED

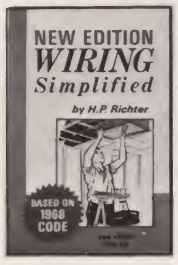
USE THIS BOOKLET AS A GUIDE FOR HOME AND FARM WIRING

This booklet was written for the guidance of everyone considering wiring work in residential or farm buildings. It was prepared to help the reader plan, select and install a modern electrical system for present or future needs. Emphasis has been placed on the "how to" aspect of both "old" and "new" electrical installations and repairs.

Specifications and recommendations given for wiring in this booklet cover typical installations. They comply with minimum safety standards established by the National Electrical Code.

FOR BEST RESULTS. It is suggested that the reader first scan this booklet quickly for an overall understanding, then go back to the beginning and review thoroughly the sections which pertain to the planned wiring job.

DETAILED WIRING INFORMATION AVAILABLE. While this booklet does cover a rather broad range of home and farm electrical wiring installation practice, many home craftsmen have a need for more detailed information on this subject. "Wiring Simplified", a 144-page manual which covers all phases of home and farm wiring procedure is available from Wards. Order it when you buy your wiring materials.



TAKE YOUR WIRING PROBLEMS TO WARDS STORES. Most wiring projects can be handled easily if instructions given in this booklet are followed carefully. However, should a home or farm wiring difficulty arise, feel free to consult with the electrical department of any Wards retail store.

MOST MEN HANDY WITH TOOLS CAN EASILY INSTALL WIRING

The installation of an electric wiring system is a project which is neither complicated, nor difficult. Anyone with average manual skill—a home owner, farmer or hobbyist—can do a workmanlike job. All that is required is the ability to follow directions and to use a few simple tools found in most home workshops. Whether done as a hobby or as part of a house repair job, electrical wiring work by the home craftsman can result in considerable savings in labor costs. In addition, doing his own wiring work can give a man the personal satisfaction which comes with a job well done.

NATIONAL AND LOCAL CODES ESTABLISH WIRING STANDARDS

For the protection of the general public, definite standards have been set up to cover both the manufacture and installation of electrical equipment. Today, no manufacturer makes equipment to suit his own standards—electrical goods must conform with safety and other standards set up by codes and associations. Likewise, no workman should install wiring to suit his fashion, but only according to code requirements. Thus, standards of adequate safety, performance and uniformity are assured in all localities.

THE NATIONAL ELECTRICAL CODE. A set of regulations which outlines standards of wiring that have been safe and adequate over a period of years is the National Electrical Code. The provisions of this code are intended only as minimum standards.

LOCAL REGULATIONS. Often, local ordinances or building codes supplement or take precedence over the National Electrical Code. The use of certain generally accepted materials may be limited in some areas. Determine if the materials such as armored cable, non-metallic cable, etc., are approved by your local code or utility company. Each installation must comply with local ordinances and building codes as well as National Electrical Code or REA (Rural Electrification Administration) requirements.

UNDERWRITERS' LABORATORIES. Many communities have ordinances requiring the use of only wiring equipment listed (usually tagged or stamped for easy identification) by Underwriters' Laboratories. This nationally accepted organization tests wiring materials and devices for minimum standards of safety and quality. Equipment is approved only for the purpose it is intended. Look for the UL label on your wiring materials as this seal of approval is your guarantee for quality and safety. It pays to use UL-approved wiring products. All Wards electrical supplies are UL-approved and meet REA specifications, where required.

USEFUL WIRING INFORMATION

ELECTRICAL TERMS YOU SHOULD KNOW

Before attempting any wiring work it is important to become acquainted with a few technical terms used in conjunction with wiring systems. Understanding the meaning of the following words will help you grasp more quickly the instructions outlined in this booklet.

TERMS OF ELECTRICAL MEASUREMENT

AMPERE—The unit for measuring amount of electrical current flowing through a wire (compares to gallons of water per minute).

HORSE POWER—Unit of electric power equal to 746 watts.

KILOWATT HOUR—Unit of measure for electric meters equal to 1000 watt hours.

VOLT—Unit used for measuring electrical pressure (corresponds to pounds of pressure in a water system).

VOLTAGE—A measure of electrical pressure between two wires of an electric circuit. When mentioned as 115 or 230 volts, voltages shall be understood to be nominal and to include, respectively, voltages of 110 to 125 and 220 to 250.

VOLTAGE DROP—A loss of electrical current caused by overloading wires or by using excessive spans of undersized wire, evidenced by dimming of lights, or slowing down of motors.

WATTS—The unit of measure for electric power. (Volts times amperes equals watts or electrical energy consumed.) One watt used for 1 hour is 1 watt hour—1000 watt hours equal 1 kilowatt hour.

ELECTRICAL TERMS

ARMORED CABLE — (commonly called **BX**) — flexible metallic sheathed cable used for interior wiring.

CIRCUIT—Closed system with two or more wires through which current flows from power source, to outlets, and return.

CIRCUIT BREAKER—A device designed to interrupt flow of electric current when circuit becomes overloaded.

CONDUCTORS—Wires through which electric current flows.

CONDUIT—Metal pipe which houses electric wiring.

FISH TAPE—Flat spring steel wire used to pull wires through walls or conduit.

FUSE—(See CIRCUIT BREAKER.)

GROUND—Connection of the electrical system to the ground to minimize damage from lightning and protect from electrical shock.

"HOT" WIRES—Power carrying wires (usually black or red).

KNOCKOUT—A circular die-cut impression made in electrical boxes which may be removed to accommodate wiring.

OUTLET—A device which provides a power source for lights or appliances.

OVERLOAD—The use of more current than circuit or equipment was designed for.

RECEPTACLE—A baseboard or wall outlet into which an electric cord can be plugged.

ROMEX—A trade name for non-metallic sheathed cable used for indoor wiring.

SHORT CIRCUIT—A power interruption usually caused by contact between a live wire and a ground wire in the same 115 or 230 volt circuit.

SWITCH—A device used to connect and disconnect an electrical circuit from the source of power.

TERMINAL—An element which connects electrical devices to a circuit.

EIGHT DO'S AND DON'TS FOR GOOD ELECTRIC WIRING PRACTICE

I. **DO**—turn off main switch of circuit control and disconnect live appliances when making electrical repairs, alterations, or rewiring.

II. **DON'T**—use wiring and equipment which does not meet the minimum standards of the National Electrical Code, or which do not have the Underwriters' Laboratory label.

III. **DO**—make sure that fuses are adequately rated and that a penny or wad of foil is never substituted for a fuse.

IV. **DON'T**—make temporary wiring repairs which do not meet the standards required for a permanent job.

V. **DO**—consider any electric equipment or connected appliance as if it is always alive and take precautions listed in No. I.

VI. **DON'T**—ever work on high-power transmission lines or entrance wires to meter. This is the responsibility of the utility company.

VII. **DO**—repair frayed, worn or defective cords, also inspect wiring for insulation breaks before power is turned on.

VIII. **DON'T**—handle "hot" electrical equipment, including fuse boxes, when standing on a damp surface or basement floor.

CONTENTS

HOW TO Plan TODAY'S Wiring System...

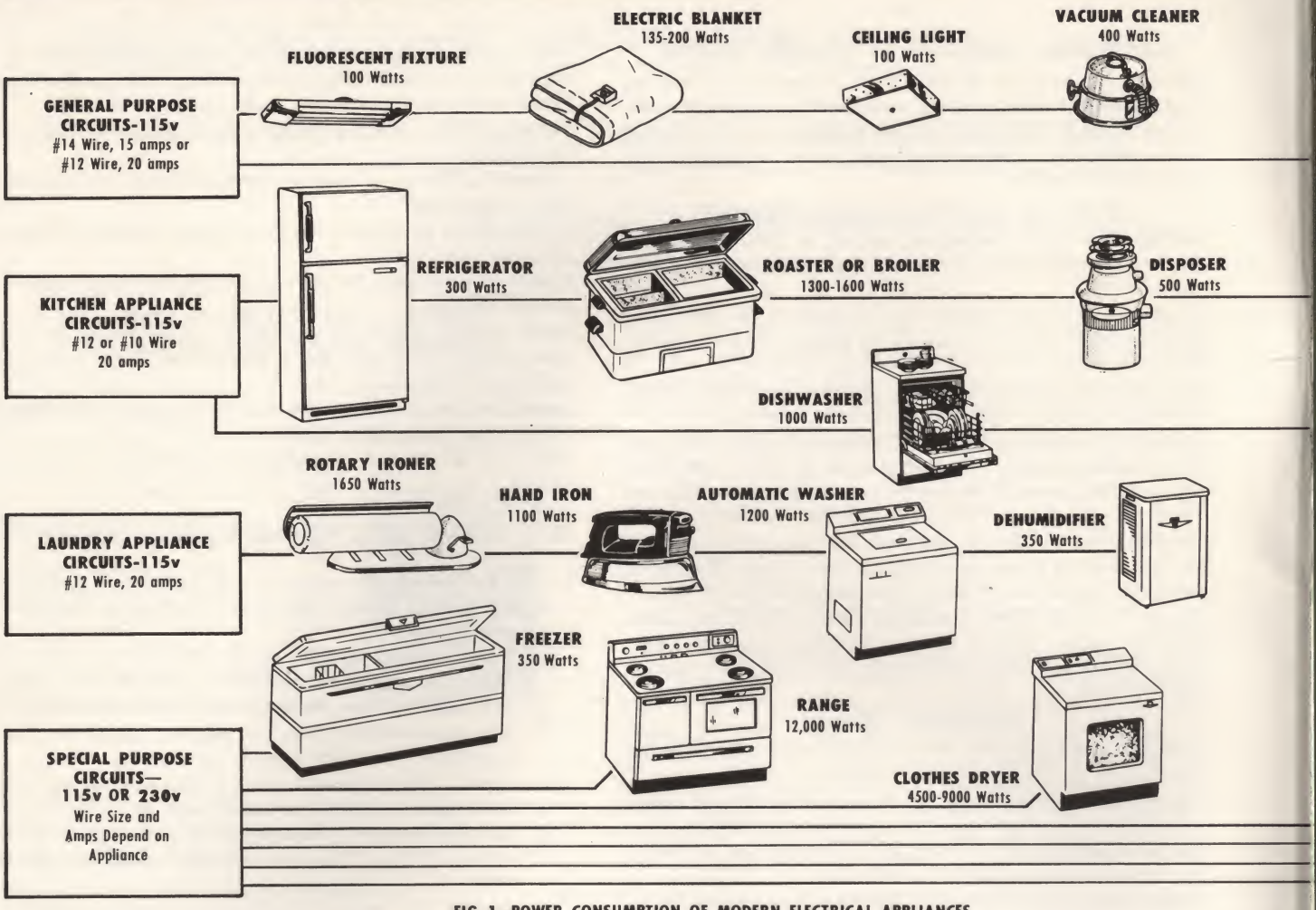


FIG. 1—POWER CONSUMPTION OF MODERN ELECTRICAL APPLIANCES

Electricity flows through wires in your home in much the same way that water flows through pipes. Just as the proper size pipe gives you a full supply of water at every faucet, the proper size wires give you an adequate supply of electricity at every outlet to safely handle the electrical load. There is, however, one important difference—overloaded electric wires become overheated and cause many fires. Each wire in your home is limited to the amount of electricity it can carry safely. (See Table II , Page 38.)

MOST HOMES INADEQUATELY WIRED. If your house is 15 or more years old, it probably has "outgrown" its wiring. When it was built, the wiring was probably sufficient for the basic electrical needs of its time. But, as more electrical devices were developed and introduced, newer standards of electrical living have become commonplace. Fig. 1 shows typical electrical appliances and the current they consume. As a result, there is a shortage of outlets in most homes. This problem is often "solved" by using double or even triple outlet plugs. These familiar "octopus" combinations, as in Fig. 2, are fire hazards and should be avoided.

Those who have overloaded their electric outlets begin to notice dimming of lights and fuses blowing out more often. Old appliances don't seem to function as well as they did when new, and new appliances fail to perform up to expectations. Actually, these appliances are "starving" from lack of electricity—almost invariably an indication of inadequate wiring. Studies indicate that even some new homes being built today may suffer from the same deficiencies. This false economy is sure to cause dissatisfaction to the owners.

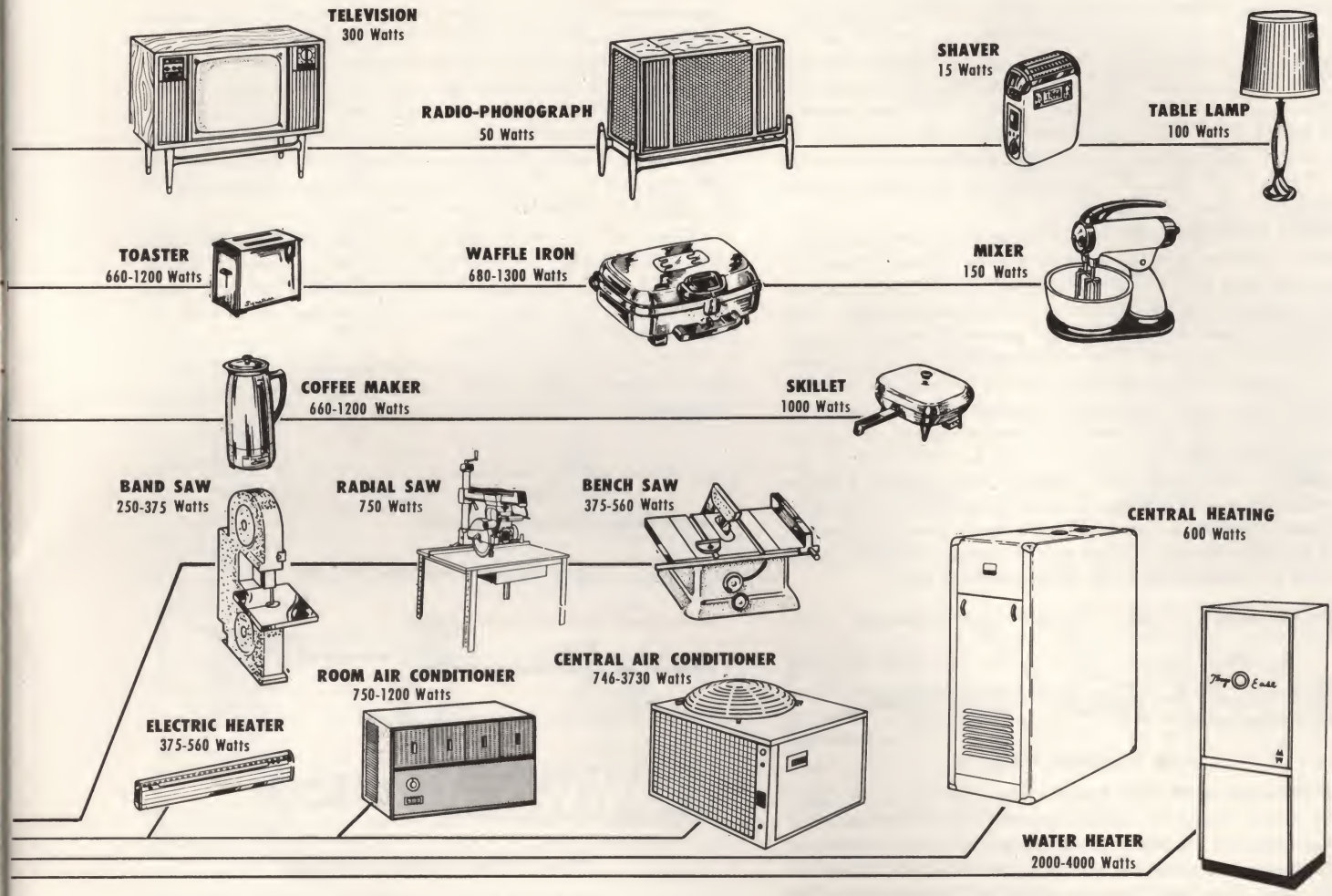
SYMPTOMS OF INADEQUATE WIRING

If your electrical system is not giving satisfactory service, perhaps you have assumed this was the fault of the power company; or, if an appliance didn't function satisfactorily, the manufacturer's product was criticized. More probably, however, the fault is with the wiring system in the building. Besides not getting the full efficiency from appliances, overloaded and overheated wires waste current. If in doubt about the adequacy of your wiring system, check the applicable square if any of the following conditions apply—

- ☐ Lights dim when appliances are turned on.
- ☐ Toasters, heaters, irons heat up too slowly.
- ☐ Fuses blow or circuit-breakers trip too often.
- ☐ Television picture shrinks in size or becomes hazy when electrical appliances are turned on.
- ☐ Motors overheat or slow down under normal work load.
- ☐ Need for multiple or "octopus-type" connections to operate several appliances.
- ☐ Long cords strung around room to plug in lights.

If you have checked any of the above items, your wiring system is probably inadequate, and should be modernized.

....To Meet TOMORROW'S Home Needs



"ADEQUATE" WIRING IS "LOOK-AHEAD" WIRING

When a home has adequate wiring, it has capacity sufficient for both present and reasonable future electrical needs. Carefully planned, "full-powered" wiring costs a little more to begin with, but pays for itself in the long run. Ten years from now, conveniences which are now being developed can be enjoyed without investment in expensive rewiring. Table A shows recommended wiring requirements of circuits to handle many commonly used appliances or pieces of equipment.

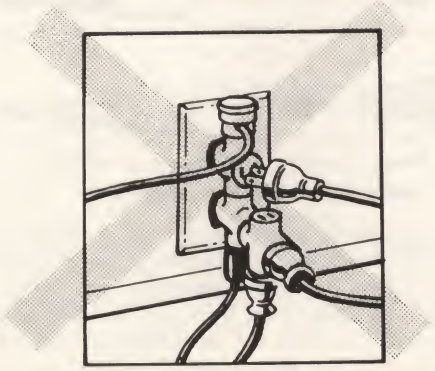


FIG. 2—"OCTOPUS" CONNECTIONS

TABLE A

TYPE OF APPLIANCE	TYPICAL WATTS	USUAL * VOLTAGE	SIZE WIRES	FUSE SIZE RECOMMENDED
Electric Range	12,000	115/230	3 No. 6	50-60 Amp.
Dishwasher	1200	115	2 No. 12	20 Amp.
Garbage Disposer	300	115	2 No. 12	20 Amp.
Refrigerator	300	115	2 No. 12	20 Amp.
Home Freezer	350	115	2 No. 12	20 Amp.
Automatic Washer	700	115	2 No. 12	20 Amp.
Automatic Dryer	5000	115/230	3 No. 10	30 Amp.
Rotary Ironer	1650	115	2 No. 12	20 Amp.
Water Heater	*Check with utility company*			
Power Workshop	1500	115	2 No. 12	20 Amp.
Television	300	115	2 No. 12	20 Amp.
20,000 Btu Air Conditioner	1200	115	2 No. 12	20 Amp.
Heating Plant	600	115	2 No. 12	15-20 Amp.
Central Air-Conditioning System	*Check with utility company*			
Space Heating	*Check with utility company*			

*Nominal voltages usually specified by manufacturers. (See explanation of voltage on Page 3.)

HOW TO SELECT Interior Wiring .....

THREE BASIC TYPES OF INTERIOR WIRING. Basically, there are three types of approved interior wiring in general use for modern residential and farm applications: 1. Flexible armored cable (usually called "BX," a trade name). 2. Non-metallic cable or "Romex", also a trade name. 3. Thin-wall conduit, also called EMT. Under certain conditions, the code calls for the use of rigid conduit (Fig. 6) and flexible electric conduit or "Greenfield" (Fig. 7). Installation of the latter two materials is described on Page 17.

FLEXIBLE ARMORED CABLE (BX). Two or three insulated wires, each of which is wrapped in spiral layers of tough paper, are protected by a galvanized steel casing (Fig. 3), It is particularly recommended for indoor use in dry areas for either old or new work, especially where a good ground arrangement, such as connection with city water system piping (Fig. 99) is available. CAUTION: BX is not designed for use out-of-doors or underground. It is easy to install and acceptable in most localities. It affords a continuous ground and provides good mechanical protection to the wires. Use it indoors, for both exposed and concealed work—along walls, ceilings, etc., or in hollow spaces of walls, floors and ceilings. This cable may also be imbedded in plaster or other masonry, except in damp locations. Because it is versatile and easy-to-use, it is frequently selected for extension of conduit systems or for remodelling work.

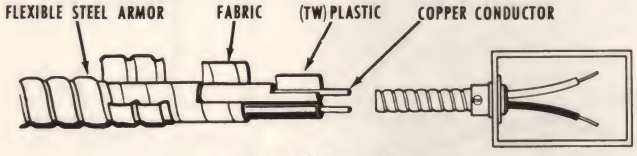


FIG. 3—ARMORED CABLE—"BX"

NON-METALLIC SHEATHED CABLE. This Type NM cable, (generally called "Romex"), is now covered with a thermoplastic jacket, with two or three insulated wires, each of which is covered with thermoplastic insulation and wrapped with spiral paper tape. This cable has a long life and is resistant to fire, moisture and acid vapors (Fig. 4). It is recommended for indoor use in homes, garages, barns and other outbuildings for both old and new work. IMPORTANT: Do not use out-of-doors, underground or in masonry. Use it inside, for both exposed and concealed work.

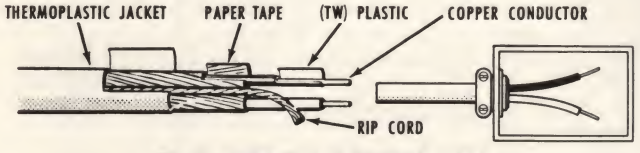


FIG. 4—NON-METALLIC SHEATHED CABLE

PLASTIC-COVERED CABLE. This comparatively new type plastic-covered cable is unusually tough and versatile. It is similar to Type NM cable, except that it has heavier insulation. A rot and fire-resistant plastic covering gives it high resistance to acids, moisture and mechanical damage. It is especially suitable for use in damp locations, such as barns, milk houses, well pits, etc. This cable can be installed in brick or masonry walls and is ideal for indoors and out, in wet or corrosive locations, or undeground between buildings.

THIN-WALL CONDUIT (EMT). Thin-wall conduit is almost universally accepted for general wiring, especially for new work. It affords greater protection to wires than other types and permits grounding of the entire system. In many cities, thin-wall conduit is the required method of wiring a new building. Note in Fig. 5 that thin-wall closely resembles steel water pipe, but has thinner walls. It is easier to cut and bend than heavier rigid conduit. Installation instructions on Page 16 explain how joints and connections are made with special threadless fittings. One of the advantages of thin-wall conduit is that insulated wires are drawn through after conduit is installed. Likewise, future wiring changes are possible without removing the conduit. Use for both concealed and exposed work, indoors and out, and in wet or dry locations. However, it should never be buried in cinders or cinder concrete.

Wires for thin-wall conduit are single strand, unjacketed and covered with thermoplastic insulation. Wards supplies this color coded wire in white, black, and red. When estimating wire quantities, be sure to allow for the correct number of feet by both color and size.

Table I on Page 38 lists various gauges of wire and indicates the number of wires which several diameters of conduit can accommodate, as well as amperages which apply.

FIG. 5—THIN-WALL CONDUIT—"TYPE EMT"

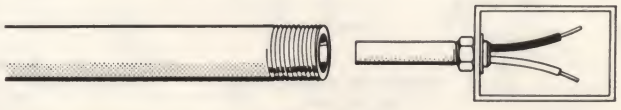


FIG. 6—RIGID CONDUIT

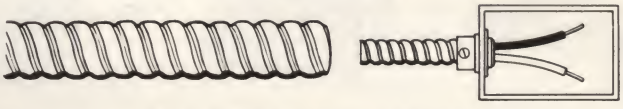


FIG. 7—FLEXIBLE CONDUIT—"GREENFIELD"

ACTUAL WIRE SIZE OF COPPER CONDUCTORS

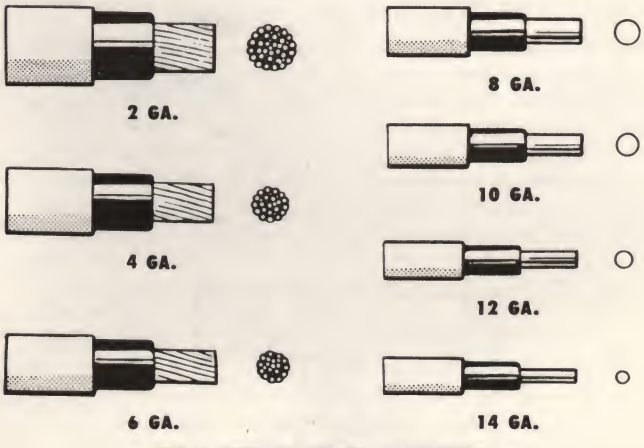


FIG. 8—SIZES OF COPPER CONDUCTORS

The correct wire size for electrical systems is important. In Fig. 8, which illustrates the actual wire sizes of copper conductors, notice that the larger the wire size number—the smaller the diameter of the wire. Wire size for different circuits should be adequate to carry the maximum anticipated loads as explained on Page 11. Determine the correct wire size for each circuit by reference to Table II, which indicates maximum circuit lengths for given load capacities. *(See Page 38.)*

MAKE Wiring Connections

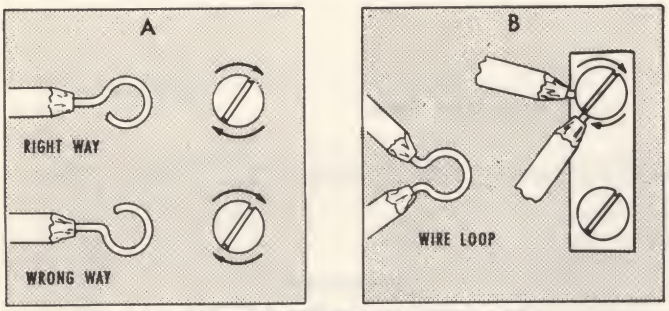


FIG. 9—MAKING SCREW TERMINAL CONNECTIONS

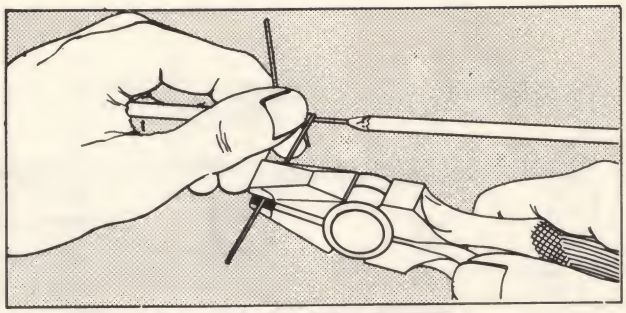


FIG. 10—SPLICING WIRES TOGETHER

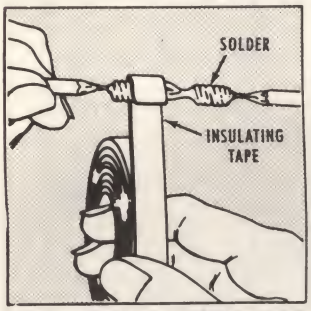


FIG. 11—TAPING A SOLDERED JOINT

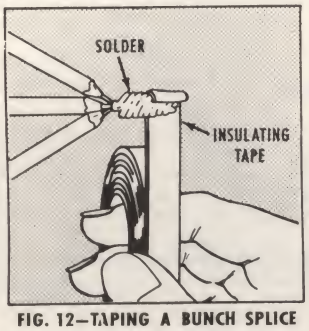


FIG. 12—TAPING A BUNCH SPLICE

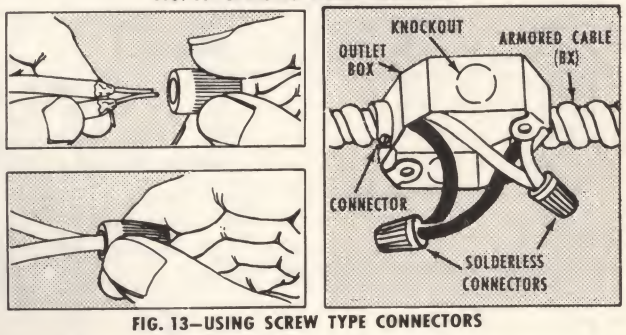


FIG. 13—USING SCREW TYPE CONNECTORS

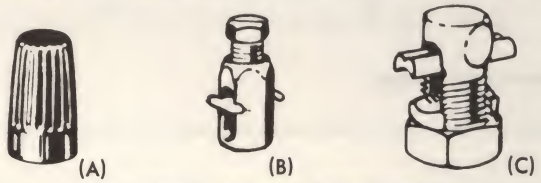


FIG. 14—TYPICAL SOLDERLESS CONNECTORS

On every wiring job there will be a need for splicing and terminating wires. A good electrical connection has several requirements. Wires must be free of insulating materials; connections should be secure and splices always covered with tape, so that wire is as well insulated as it was before insulation was removed. To avoid nicking wire, always cut insulation at a slant with a knife, as when sharpening a pencil.

SCREW TERMINAL CONNECTIONS. Fig. 9 illustrates two correct methods for fastening a wire to screw terminals on outlets, switches and other electrical equipment. Connections are made at the end of the wire or in the middle of a continuous length. About ¾ in. of wire is stripped clean of insulation for making connections. Fig. 9-A shows how end of wire is bent into a loop and inserted under screw. Tightening of the screw clockwise secures the loop tightly. A continuous wire loop is fastened to a terminal as shown in Fig. 9-B.

TECHNIQUES FOR MAKING SPLICES. A splice is the joint which results from the union of two wires to make an electrical connection. A spliced wire must be as good a conductor as an unbroken piece of wire. Where there is a strain on the wire, the splice must be as mechanically strong as a continuous wire. Splices should not be made in conductors encased in conduit, nor are they permitted between outlets and fixtures, except in junction boxes which protect the splice.

There are a variety of methods of making a splice. First, remove about 3 inches of insulation, then scrape bare wires with sandpaper. Cross wires about one inch from insulation and make 6 to 8 closely wound turns; solder and tape the joint. (See Fig. 10.)

SOLDERING SPLICED WIRES. Normally, all splices should be soldered. For best results, wire and soldering iron should be clean. Apply heat to wire at splice (not to solder) until wire is hot enough to melt solder. Rosin core solder can be applied best with soldering gun or an electric soldering iron.

COVER SPLICES WITH TAPE. Soldered splices can be covered with one or two wrappings of plastic tape or wrapped with rubber and friction tape, as shown in Fig. 11. When joining two or more wires, a bunch splice (Fig. 12) is employed. At a ceiling outlet where a number of wires are spliced, wires should be twisted together, soldered and taped.

SOLDERLESS CONNECTORS SAVE TIME. A quicker and more satisfactory method for joining wires is simply to use convenient solderless connectors (or wire nuts). See Fig. 14-A. If there will be no strain on the wire, as in an outlet box, solderless connectors are used. Fig. 13 shows how wires are inserted into plastic caps, which are screwed tight. *Be sure no bare wire is left exposed.*

HEAVY DUTY CONNECTORS. On wires to outbuildings and on power feed lines, heavy-duty type solderless connectors are used. The connector shown in Fig. 14-B is for tapping an existing line where there is a strain on the wires. Fig. 14-C shows a connector designed for service entrances and must be insulated with plastic tape, or rubber and friction tape.

ALL-PURPOSE CRIMPING TOOL. A hand tool which requires only a modest investment, but which will pay large dividends in convenience, is a crimping tool (Fig. 15) available from Wards. The multi-purpose instrument is used to cut wire, and crimp and splice terminals or connectors. It will strip insulation from wire cleanly, shears bolts and indicates wire and stud gauges. With this crimper, hobbyists can easily repair a toaster, iron, mixer and other appliances. Wiring work on boats and vehicles is simplified. Fig. 15 also shows some styles of terminals used with the crimper. *Do not use these terminals for splicing wires in outlet boxes or for connecting switches.*

FIG. 15—CRIMPING TOOL AND SOLDERLESS TERMINALS

HOW TO BEGIN Planning.....

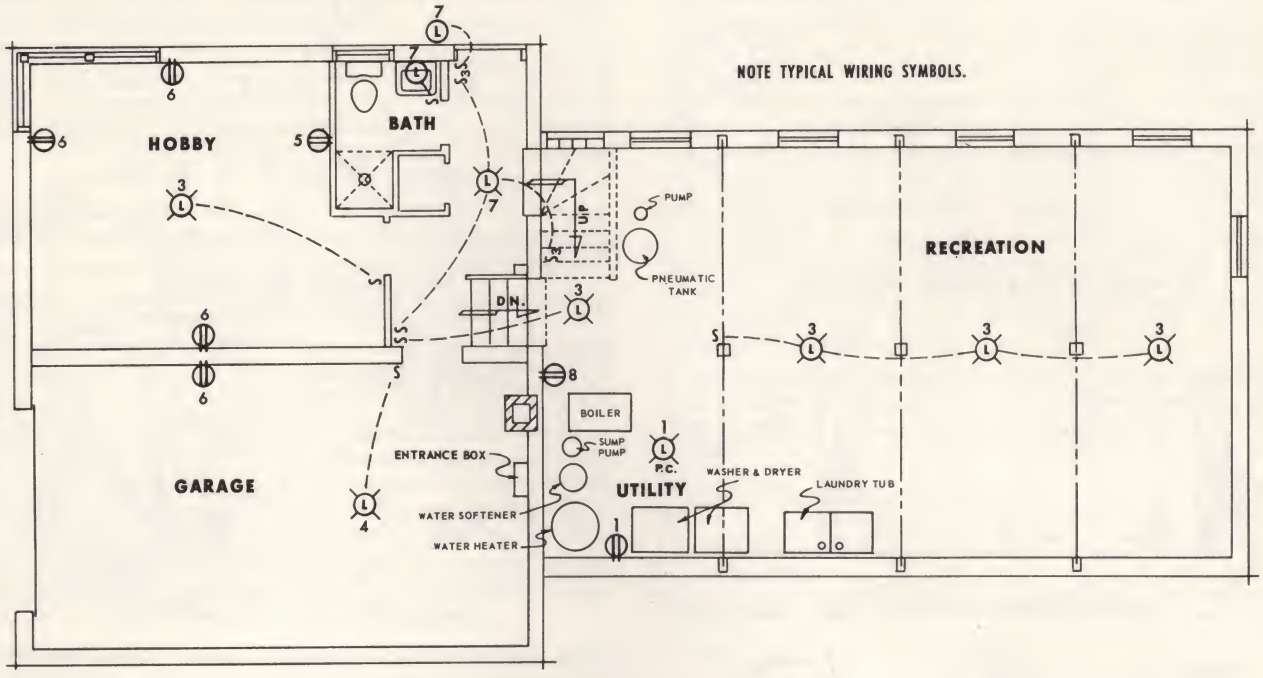


FIG. 16—WIRING LAYOUT PLAN VIEW OF 1st and 2nd LEVELS.

CHECK ELECTRICAL CODE FIRST. After carefully considering your home or farm building wiring needs, it is best to check with local authorities to see if a permit is needed, or to learn the requirements of any applicable code; also, you should know your utility company's wiring regulations. In many localities a permit is not essential for minor wiring alterations. Before ordering wiring materials, particularly the entrance switch, it is important to know if they are approved for installation in your area. A few minutes spent in learning local wiring standards for materials and installation will eliminate the possibility of having to do the job over. In the absence of a local code, the provisions of the National Electrical Code should be followed (See Page 2.).

MAKE SKETCH OF JOB AREA. Next, make a simple pencil sketch plan of the room, or floor plans of home, barn or outbuildings where wiring is to be done. Use the ruled space provided on Page 37 for making sketch. Instructions for making wiring sketches are on Page 36.

STANDARD ELECTRICAL SYMBOLS. Note the list of wiring symbols on Page 9. Use these symbols to designate light and plug-in outlets and switches. Indicate locations of appliances, power tools, heaters, etc., including those planned for the future. Figs. 16 and 17 show use of standard electrical symbols and how circuits are layed out and indicated by number. Rooms, wall partitions, doors and windows should be shown on the drawing. Each outlet should be indicated by circuit number.

Use completed sketch plan for estimating wiring components required to complete the installation. Make a list of needed wiring materials; they can be selected at any Wards retail or catalog store or ordered from Wards General Catalog. Order blank and addressed envelope are enclosed with this booklet for your convenience. All Wards electrical supplies are UL-approved and meet REA specifications, when required.

FEW SPECIAL TOOLS REQUIRED. Be sure that tools needed for the electrical installation are on hand before beginning the job. Most home owners already have nearly all of the tools required for electrical work. The tools listed below are, in general, items found in most households and others which may be borrowed from friends or purchased. Order tools needed from Wards catalog, or at your Wards retail or catalog store.

TOOLS FOR ELECTRICAL WORK

Pliers (long nose, lineman's, sidecutting)	Jack Knife
Screwdrivers (assorted sizes)	Small Wrenches
Soldering Iron (with solder, flux, etc.)	Brace
Tape (plastic, friction, rubber)	Crosscut Saw
Wood Bits (various sizes)	Keyhole Saw
Circuit Tester (Fig. 112-B)	Hammer
Crimping Tool (Fig. 15)	Hacksaw
Conduit Bender (Fig. 39-A)	Fish Tape (Fig. 42.)
Non-Metallic Cable Ripper (Fig.36-F)	6 Ft. Folding Rule

Of course, the type of tools required for the individual wiring job depends upon the particular installation to be undertaken. Common sense should dictate which tools are needed.

.....Your HOME WIRING Job

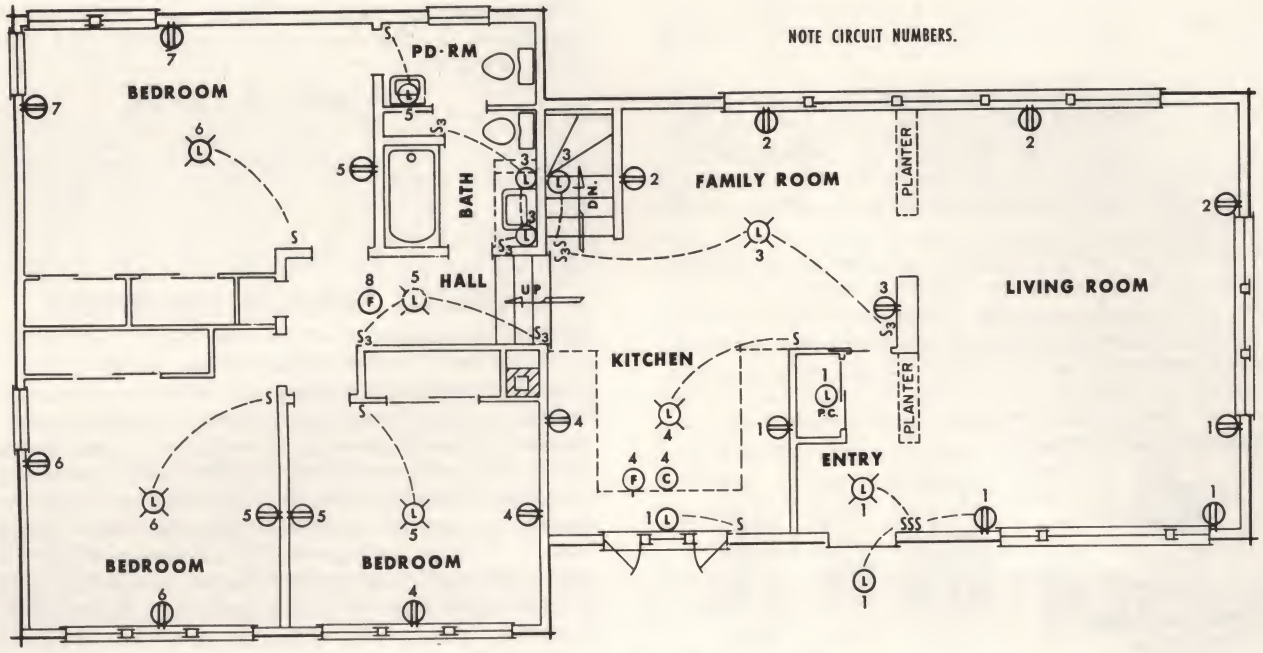


FIG. 17—WIRING LAYOUT PLAN VIEW OF 3rd and 4th LEVELS.

STANDARD ELECTRICAL SYMBOLS

- CEILING OUTLET
- WALL OUTLET
- (L) CEILING LIGHTING OUTLET
- DUPLEX CONVENIENCE OUTLET
- (S) SWITCH—CONVENIENCE OUTLET
- (WP) WEATHERPROOF OUTLET
- (R) ELECTRIC RANGE
- (D) ELECTRIC DRYER
- 230-VOLT POLARIZED OUTLET
- SPECIAL PURPOSE OUTLET
- (F) CEILING FAN
- (F) WALL FAN
- (J) CEILING JUNCTION BOX
- (J) WALL JUNCTION BOX
- (S) CEILING PULL SWITCH
- (C) CLOCK OUTLET
- (T) THERMOSTAT
- (G) GENERATOR
- (M) ELECTRIC MOTOR
- NIGHT LIGHT
- PUSH BUTTON
- DOORBELL
- DOOR BUZZER
- (R) RADIO OUTLET
- (TV) TELEVISION
- S SINGLE POLE·SWITCH
- S_2 DOUBLE-POLE SWITCH
- S_3 THREE-WAY SWITCH
- S_4 FOUR-WAY SWITCH
- S_{WP} WEATHERPROOF SWITCH

HOW TO SELECT and FIGURE .....

TWO TYPES OF SERVICE ENTRANCE SWITCHES

The service entrance switch provides overload protection, not only for branch circuits, but also as a means for disconnecting all current from power lines when making changes or repairs on the wiring system.

Two types of service entrance switches are in general use. The most common and least expensive is the fuse type (Fig. 20) with replaceable fuses. The other is the fuseless or circuit breaker type (Fig. 21). The latter is to be preferred, as breakers are simply reset when overloads occur—they need not be replaced.

Each type is rated in amperes and must be of sufficient capacity to accommodate the maximum amount of current which will be used *at one time*. When selecting the entrance switch, consider both your present and future electrical needs. Wards recommends the 100 ampere (24,000 watts) capacity switch as the minimum for average residential use. Larger homes, or those with more than average electrical demands, should have up to 200 ampere capacity entrance switches.

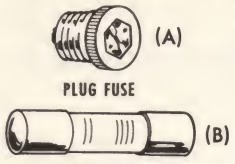


FIG. 18—TYPICAL FUSES

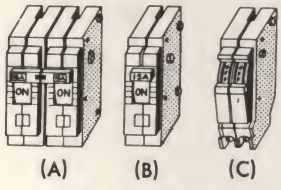


FIG. 19—CIRCUIT BREAKERS

USES OF FUSE TYPE EQUIPMENT

Modern combination fuse type entrance switches eliminate the need for separate safety switches for individual 230 volt appliances. Two cartridge type fuses (Fig. 18-B) for protecting the range, water heater or dryer are mounted on a removable block which can be easily pulled from the entrance switch; fuses can be removed while block is in your hand—the circuit remains dead. Plug type fuses (Fig. 18-A) protect 115 volt circuits. These fuses are available in standard tamperproof time delay and circuit minder types.

In addition to "pull out" blocks for 230 volt appliances, some types of entrance equipment have a main "pull-out" switch (Fig. 20-C) for shutting off all current entering through the service entrance switch. This main disconnect is fused to the total amperage capacity of the box.

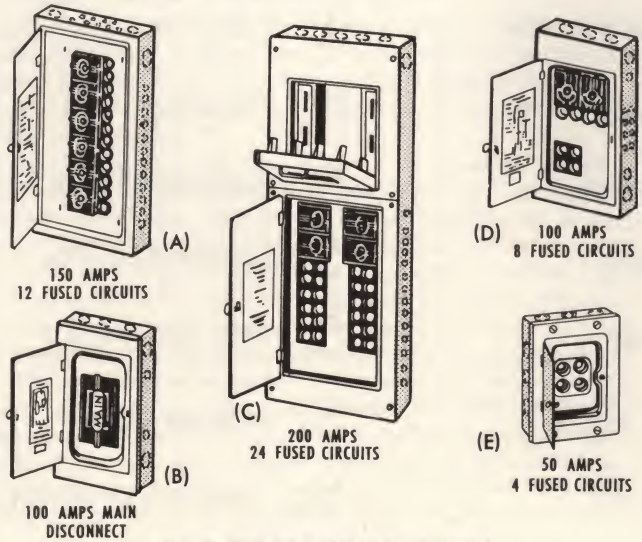


FIG. 20—FUSE TYPE ENTRANCE SWITCHES

As a rule, the main disconnect and the branch circuit fuses share the same cabinet. In some cases, however, local code or building needs may require a separate main disconnect switch installation. A fuse box housing only plug type fuses is shown in Fig. 20-E.

FUSES BLOW FOR A REASON

When a fuse blows or a circuit breaker trips, it is a danger signal which calls for investigation of the cause. Something connected to a circuit may be defective, or too many devices are in use on the circuit at one time. If a fuse blows when a motor device is turned on (motors draw much more current when starting), a time delay fuse may solve the problem.

CIRCUIT BREAKER EQUIPMENT

Circuit breaker entrance switches (see Fig. 21) have a marked advantage over fused equipment. Fuse blowouts caused by temporary overloads are eliminated. When a circuit is overloaded or a "short" occurs, the breaker will trip automatically, stopping the flow of electricity through that conduit. To restore service, find and correct fault and flick handle to "on" position. Circuit breakers take temporary overloads such as the starting of a washing machine, refrigerator, etc., without tripping. To disconnect all power, flick handles on all circuits to "off" position unless a separate disconnect switch is installed between power lines and entrance switch as shown in Fig. 24, Page 12.

Circuit breakers commonly used include: double pole breaker (Fig. 19-A), single pole breaker (Fig. 19-B and twin single-pole breaker (Fig. 19-C).

Each 230 volt circuit requires a double pole breaker. No current-carrying parts are exposed in circuit breaker assemblies.

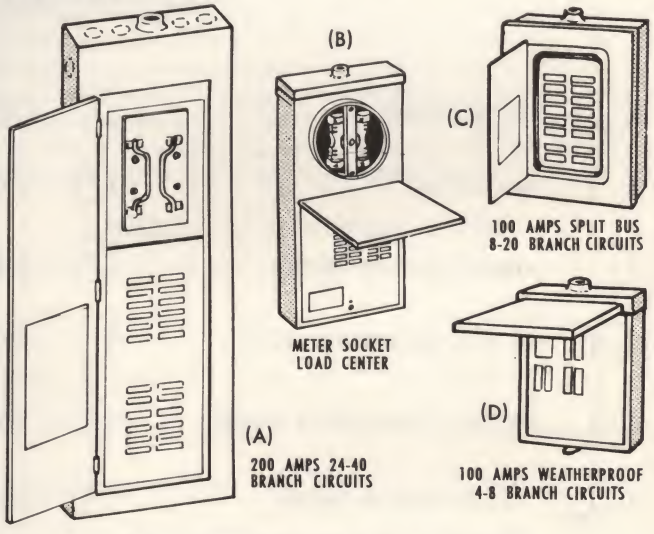


FIG. 21—CIRCUIT BREAKER ENTRANCE SWITCHES

ADD CIRCUIT BREAKERS AS NEEDED

Circuit breaker equipment is available in three styles. One style has a 100 Amp main breaker or a 200 Amp main knife switch included. (See Fig. 21-A.) Another style is internally wired in such a manner as to accommodate one or more double pole (230 volt) breakers as a main disconnect (Fig. 21-C). These are commonly called "split-bus" design. Another style is available without any main disconnect means and may be used with a separate main switch as shown in Fig. 21-D. Check your local electrical code (or utility company) before installing this equipment.

CAUTION: Never attempt to remedy current interruptions by substituting oversize fuses or breakers.

Service Entrance Equipment Capacity

In some areas, the entrance switch and the meter socket are combined into one unit for outdoor mounting. (See Fig. 21-B.)

A home's electrical system begins at the point where the utility company's power line is connected to the house or yardpole. The owner supplies all the materials except the meter, which is generally furnished by the utility company. While meter sockets are usually furnished by the electric company, there is a growing tendency for the customer to supply this item.

Beginning with the service head fitting, the service entrance wires are fed through the meter and brought into the house (usually through the basement—as illustrated on Pages 12 and 13). Here is where the main disconnect switch and branch circuit fuses or circuit breakers are placed. (See Fig. 22.) Some local codes require that main disconnect switches be outdoors. From this junction point, branch circuits transmit the current to various rooms in the house.

Plan *now* to avoid a service entrance "bottleneck" *later*. All present and future use of electricity in your home is governed by the capacity of its service entrance equipment (wires and service switch). The addition of a single appliance may necessitate replacement of the wires or the service entrance switch, if either is too small. The capacity of the service entrance switch should match that of the entrance wires.

Often, just because "3-wire" entrance equipment has been installed, the wiring is assumed to be "adequate." This, of course, is a mistake. It may handle one or two major appliances such as a range or water heater, but any additional appliances may require larger size service entrance equipment. For example, a 3-wire system may be rated at 60 amps (while Wards recommends 100 amp as a minimum), or the wire sizes might be inadequate. Wire, main switch and fuse capacities are *always* the controlling factors.

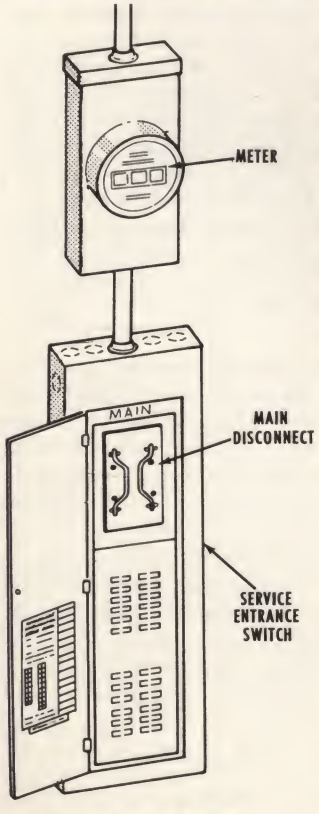


FIG. 22—SERVICE ENTRANCE EQUIPMENT

If, for any reason, the entire electric system cannot be as complete as desired at the beginning, it is recommended that at least adequate service entrance equipment be installed. Branch circuits for handling additional appliances can be installed later. Remember that no matter how large the service entrance is, you never pay for more electricity than you actually use. By allowing for future expansion, you save money in the long run.

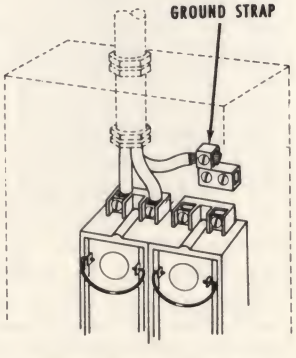


FIG. 23—SERVICE ENTRANCE TERMINALS

The electrical capacity required will, of course, be governed by the kind and number of electric appliances and equipment. For example, some homes are equipped with gas appliances including the refrigerator, range, water heater, clothes dryer, and even central air conditioning. Obviously, a gas equipped home would not require an electrical service equal to that of an all-electric home. Consequently, it is recommended that the service entrance equipment be sized on the basis of actual load, with allowance for additions in the future. However, the following "rule of thumb" method may be used as a quick check, when all the usual appliances will be electrical. First, measure the square foot floor area of your home. Multiply length, times width of all finished areas of first and second floors, including spaces in attic and basement which are finished or will be used later. *Do not include the garage or open porches.* Using this figure as a guide, the service entrance wires and equipment should be approximately as shown in the table below—

TABLE B—SERVICE ENTRANCE CALCULATION

SQ. FT. AREA	NO. ENTRANCE WIRES, SIZE & AMPERAGE	CIRCUIT BREAKER (AMPS)	MAIN LUGS (AMPS)	MAIN FUSE (AMPS)
UP TO 1000	3—#6—70	70	100	60
OVER 1000	3—#2—100	100	100	100
	or 3—#1/0—150	150	150	150
	or 3—#3/0—200	200	200	200

The 3-wire (115/230 volt) entrance equipment listed in the table above provides for normal lighting and plug-in-appliances, including an ironer, toaster, refrigerator, clothes dryer, a range and water heater. Ample reserve power is allowed for additional branch circuits to handle major appliances which may be bought in the future. If wattages specified seem destined to be exceeded in years to come, (such as for a central air-conditioning system) select the next larger size service entrance or consult the electric utility company. Consult Table A, on Page 5 for wattages of typical household appliances.

PLAN ENOUGH BRANCH CIRCUITS

Modern house circuits are divided into the following 3 general classes, according to their use:

GENERAL PURPOSE CIRCUITS. They serve lights in all parts of the house and convenience outlets, except in the kitchen, laundry and dining areas. These circuits usually require No. 14 wire which cannot be fused at more than 15 amperes, up to a maximum capacity of 1750 watts. For today's systems, we recommend the No. 12 wire as the minimum size, fused at 20 amperes to handle up to 2300 watts. Plan one of these circuits for each 500 sq. ft. of floor area. Divide outlets evenly among circuits on different floors to avoid complete darkness if a fuse blows.

APPLIANCE CIRCUITS. Install convenience outlets, independent of lighting fixtures, in the kitchen, laundry and dining areas to serve refrigerator, washing machine and portable high wattage appliances. Plan at least one circuit of this type, using No. 12 wire. If more than one heavy-duty appliance will be connected to the same circuit, the use of No. 10 wire is recommended. It is more practical to install three appliance circuits—two for kitchen appliances and one for laundry room or basement. (See Fig. 1, Page 4.)

INDIVIDUAL CIRCUITS. Wire size and types of fuses or circuit breakers needed for individual circuits serving one piece of major electrical equipment, such as a clothes dryer, range, water heater, electrical space heater, air conditioner, etc., will depend upon the amperage rating of these appliances.

CAUTION: Never attempt to remedy current interruptions by substituting oversize fuses or breakers.

HOW TO INSTALL Conduit and .....

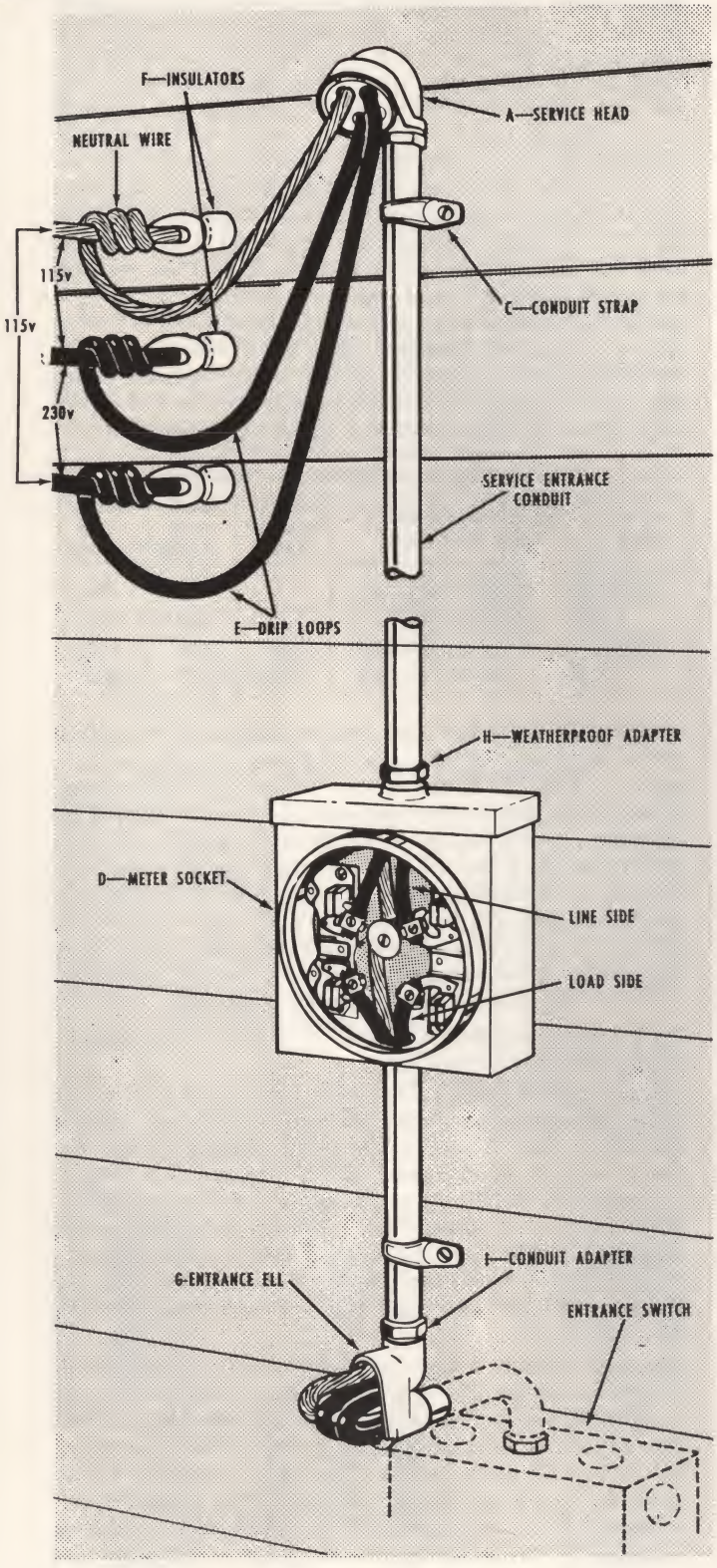


FIG. 24—SERVICE ENTRANCE USING CONDUIT

SELECT CONDUIT SIZE. Study recommendations on Table A and select conduit size which corresponds to the service entrance wires to be installed. NOTE—*Under no circumstances should service entrance conduit runs exceed 50 feet.*

Pages 4 and 5 discuss reasons for having ample power capacity in reserve for future needs. The meter is supplied by the utility company which usually furnishes and installs all wiring leading to the meter, and in some areas, including the meter socket (Fig. 24-D) Some utility companies require that the customer provide the meter socket. All wiring on the house side of the meter is the home owner's responsibility.

Use of thin-wall conduit (Page 16) or rigid conduit (Page 17) depends largely upon local regulations. Before starting the job, consult local utility company to determine the kind of wiring system which will be accepted; also, learn where the service entrance should enter the building, and if a yardpole or service mast kit will be needed.

INSTALLATION PROCEDURE. The incoming power lines are anchored to the building or yardpole by service insulators which are installed as high as practical. The National Electrical Code requires a clearance of at least 10 feet above sidewalks and 18 feet above driveways. On farms, be sure to provide substantial clearance for loaded wagons or trucks. Keep these wires at least 3 feet from doors, windows and other exterior openings.

The service head (Fig. 24-A) must be attached to the building above the topmost insulator as shown in Fig. 24-F to prevent rain from entering the system. If the building is low, a steel service mast or a 4x4 in. wooden mast may be used to elevate the service wires, as illustrated in Fig. 25. Connect conduit, using a metal strap (Fig. 24-C) every 4 feet, to fasten to the building. Attach conduit to meter socket (Fig. 24-D) with a weatherproof adapter (Fig. 24-H). Rigid conduit is connected by standard pipe threads which are cut at both ends.

At point where conduit is to enter house, use an entrance ell (Fig. 24-G) with a removable cover. When cover is taken off, it will be a simple matter to pull wires through. The threaded tappings in the fittings should be the same size as that of the conduit being installed. Connect conduit to ell with thin wall conduit adapter (Fig. 24-I). Adapters are not used with rigid conduit. Anchor the conduit and tighten all parts of service entrance assembly to make both strong mechanical joints and a good grounding connection.

NOTE: Service entrance switch should be installed inside of building within one foot of place where conduit enters wall. Always connect the black and red incoming wires to the heavy terminals of the entrance switch (Fig. 23).

INSERTING THE WIRES. After the conduit is completely installed, it will be an easy job to pull the wires through. Three continuous and unspliced wires, generally building type wires "TW", "R" or "RHW", are used . . . having one each, white, black and red wire. The white wire is *always* the neutral or ground wire; the black *and* red wires give 230 volts, while the white with either the black or red gives 115 volts.

Connect wires to proper terminals on the meter socket, as shown in Fig. 24-D). Where short wire lengths are involved, use of fish tape will not be necessary. Allow ample wire length—at least a 3 foot projection—outside of the entrance head for drip loop connections to incoming power line (Fig. 24-E). Measure distance from top of conduit to meter socket and allow about 8 in. for making connections after wire is cut. Handle other wires from inside of house and push into entrance ell and up through conduit, terminating at meter socket. If run is long or has bends in it, push fish tape—see Fig. 42—(or clothes line type wire) into conduit, then attach wires and pull them through.

TESTING WIRING. *After wiring is installed, it should be tested before power is connected. (See Page 38.) Follow procedure for grounding system as described on Page 31.*

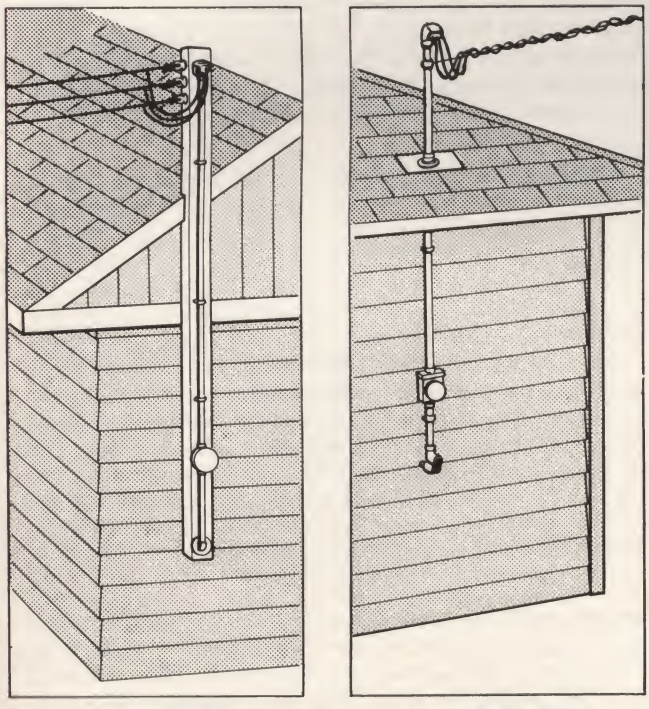
Cable Service Equipment

Because it is lower in cost and generally easier to handle than conduit, service entrance cable (Fig. 26-G) is most frequently used for service entrance installations. Its flexible construction permits easier handling around corners, bends, etc. Type to be used will be governed by the local code. In selecting cable size, be sure to allow for future power requirements. (See Table B, Page 11.)

INSTALLATION INSTRUCTIONS. The installation of service entrance cable does not differ greatly from the procedure for installing conduit on Page 12. Here again the service head must be securely attached to the building, at least 10 feet above the ground. Install the service head so that it projects above the topmost insulator to protect the system from rain penetration. (See Fig. 26A.) On low buildings, such as ranch homes, a steel service mast or 4 x 4 wooden mast can be used as in Fig 25. Power line clearance and other pertinent information is presented on Page 24.

Cut a length of service cable long enough to reach from meter to entrance head, *plus* about 3 feet extra to allow for drip connections to power line. Strip the outer cover from end of cable so that the 2 lead wires and one standard neutral wire will extend separately at least 3 feet outside of the service entrance head (Fig. 26-A.). Note that the *ground* wire of service entrance cable consists of several uninsulated wires spirally wound around two insulated wires. Simply bunch these together and twist them to form a third wire and insert all 3 wires through entrance service head.

Secure cable to building every 2 feet with metal straps (Fig. 26-D) and anchor to meter socket with watertight connectors (Fig. 26-C). From meter, run cable down wall to hole drilled through side of building and connect to service entrance switch, which should be within one foot of point where cable passes through wall. Wire connections at the entrance switch are the same as for conduit. (See Fig. 23.)



A—4 X 4 WOODEN MAST **B—STEEL MAST KIT**

FIG. 25—TWO METHODS FOR ELEVATING SERVICE ENTRANCE WIRES

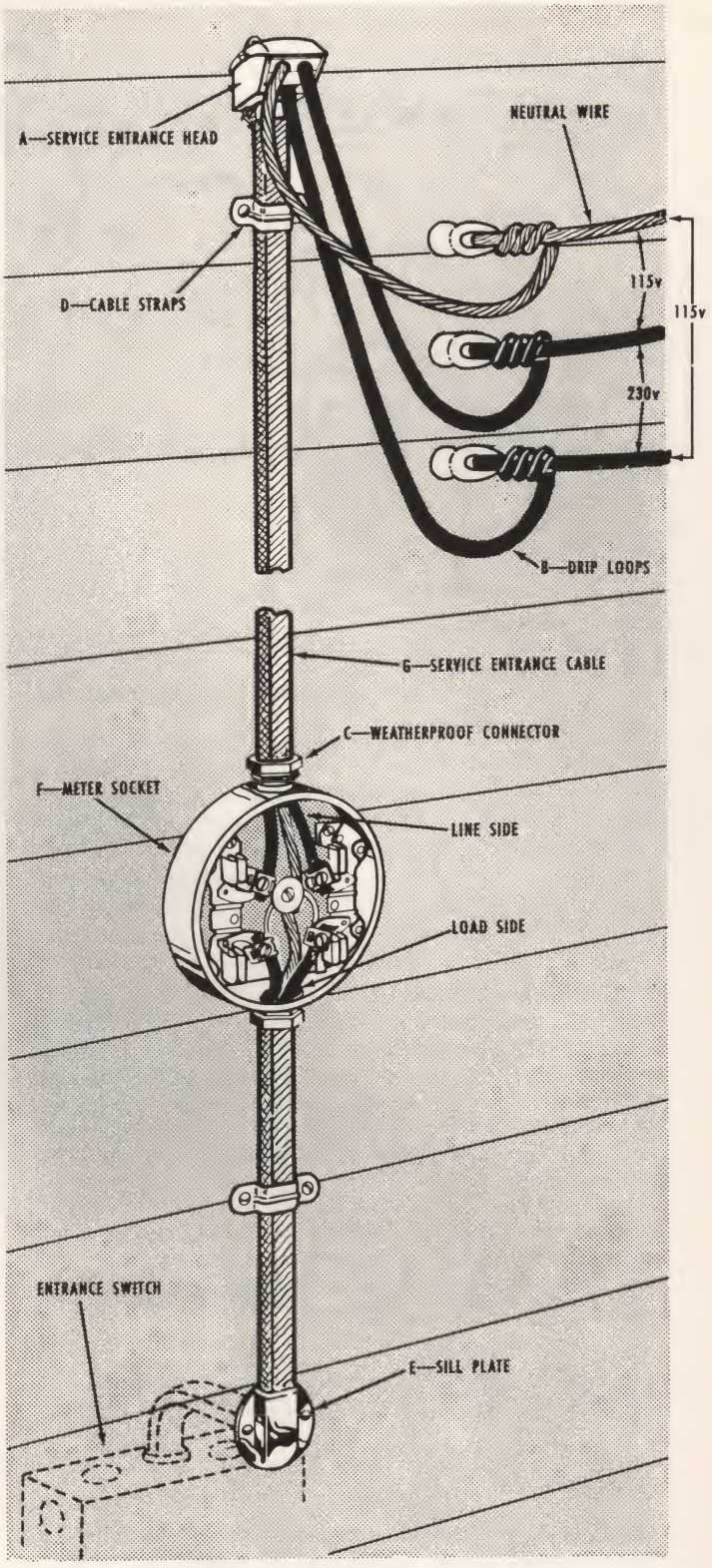


FIG. 26—SERVICE ENTRANCE USING CABLE

SILL PLATE KEEPS OUT RAIN. Where the service entrance cable enters buildings, install a sill plate Fig. 26-E and pack tightly with weatherproof compound (usually furnished with sill plate) to prevent rain from following cable into building.

GROUNDING PROCEDURE. *As a safety precaution, all electrical systems, and some electrical equipment, should be grounded as described on Page 31.*

HOW TO INSTALL Armored Cable.....

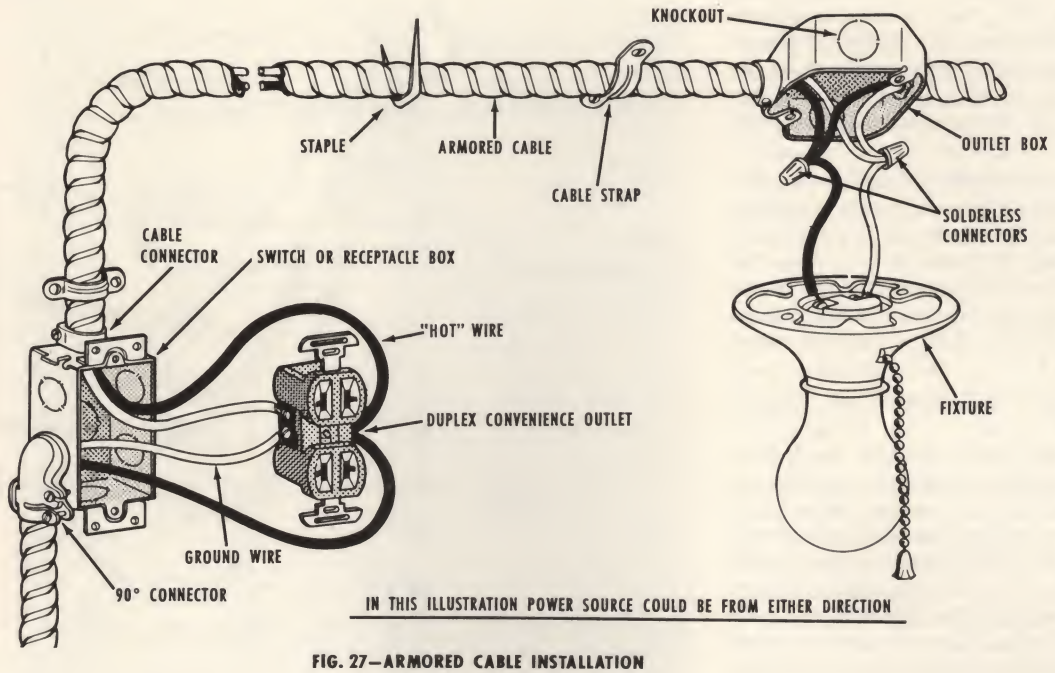


FIG. 27—ARMORED CABLE INSTALLATION

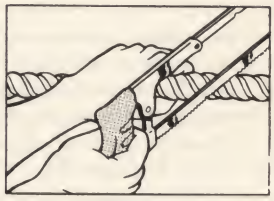


FIG. 29

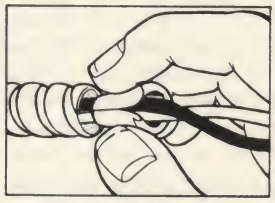


FIG. 30

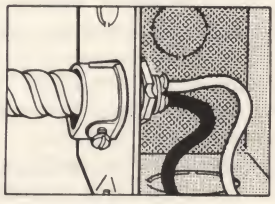


FIG. 31

Commonly referred to as "BX", armored cable is subject to somewhat the same installation requirements as non-metallic sheathed cable (Page 15). The characteristics of BX are described on Page 6. This cable is installed in steel outlet boxes only—*never use with bakelite or porcelain boxes as they break the continuous ground.* Consult Table II on Page 38 for wire size selection.

CUTTING ARMORED CABLE. A fine-tooth hacksaw is used to remove the spiral wound steel armor. Fig. 29 shows how saw is held at right angles to the strip of armor. Carefully cut through one section of the armor, making certain that saw goes through armor but does *not* cut the insulation of the wires. Next, grasp cable with one hand on each side of cut. Give it a twist and remove the short end. Expose about 8 inches of insulated wire for connections.

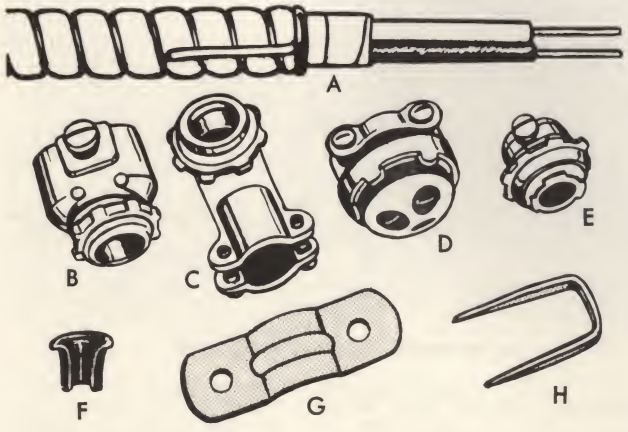


FIG. 28—ARMORED CABLE COMPONENTS

INSERTING THE BUSHING. The Underwriters' Code requires the insertion of a protective fiber bushing at the cut end of the "BX" cable. After the BX has been cut, the resulting raw edge might break the wire insulation, which could result in a short circuit or ground. To allow room for bushing, unwrap paper from around wires up to a few turns under the armor. Pull wrapping sharply so it will tear off inside armor. Insert bushing as illustrated in Fig. 30. Fiber bushings are furnished separately with Wards armored cable. No. 14 and No. 12 BX have a bonding wire (see Fig. 28-A) which should be bent back before inserting the bushing. *Local inspectors will not pass armored cable installations if bushings are not used.*

CONNECTING BX TO OUTLET BOXES. If outlet boxes have built-in cable clamps, BX is held fast by tightening the clamp screw. Use cable connectors when boxes do not have clamps. When a cable connector (Fig. 28-E) is used, take BX with bushings installed, slip connector over end of cable (threaded end out) and tighten holding screw. Punch out knockout slug in box and insert connector into hole (Fig. 31). Anchor BX securely by tightening the connector locknut firmly on the inside of the box to insure a strong and well-grounded connection, or use tapped grounding hole and screw or clip. To tighten locknut, hold a screwdriver on rim and tap lightly with one hand (Fig. 34). Support cable with straps (Fig. 28-G) or staples (Fig. 28-H) at 4½-foot intervals and within 6 to 12 inches of every outlet or switch box, except for concealed runs in old work, where cable is fished through walls or ceilings.

ARMORED CABLE FITTINGS. Job variations may require use of armored cable accessory fittings. Use duplex connector (Fig. 28-B) when fastening two pieces of cable through one knockout. A 90° angle connector (Fig. 28-C) accommodates two wire, No. 14 BX. To change from 2- or 3-wire cable to open wiring, use end fitting (Fig. 28-D). Ground connections are explained on Page 31.

GROUNDING PROCEDURE. *As a safety precaution, all electrical systems, and some electrical equipment, should be grounded as described on Page 31.*

Non-Metallic Cable

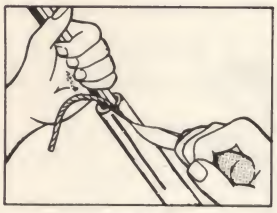


FIG. 32

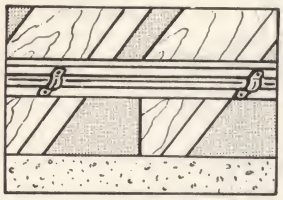


FIG. 33

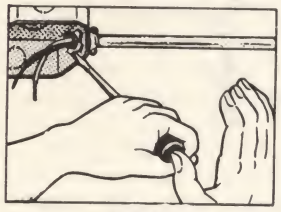


FIG. 34

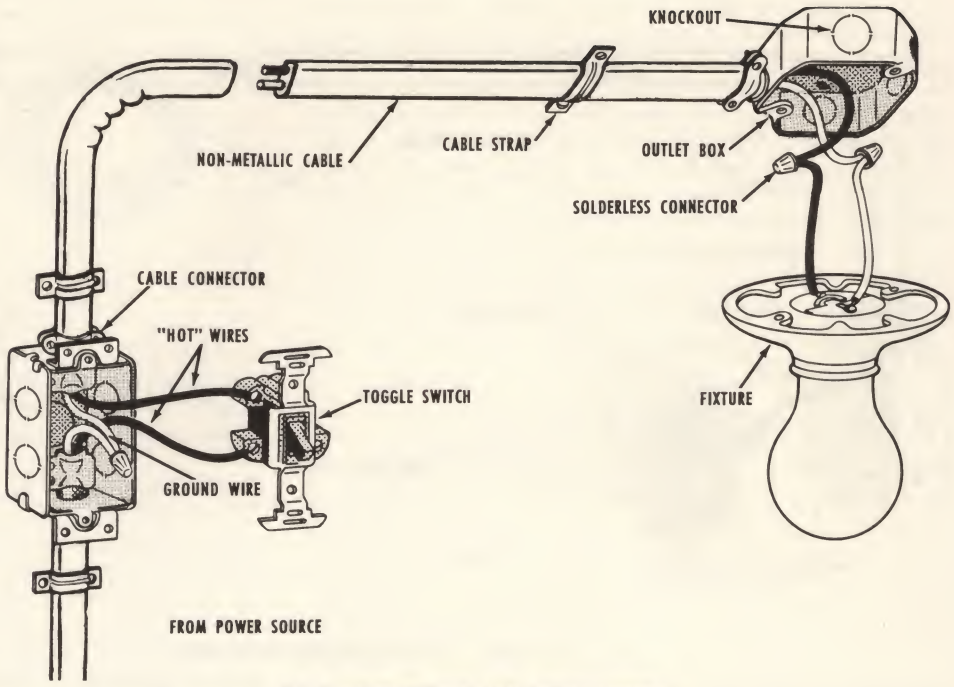


FIG. 35—NON-METALLIC CABLE INSTALLATION

NO SPECIAL TOOLS REQUIRED. Non-metallic (Fig. 36-B) costs less than other kinds of cable in common use. It is lightweight and can be installed without special tools. Romex is used indoors with *either* steel or bakelite boxes. Heavier (Type UF) plastic-covered cable (Fig. 36-C) is installed like Type NM.

REMOVE OUTER COVER WITH CARE. Use handy cable ripper (Fig. 36-F) or an electrician's knife to slit braid of Romex. Remove about 6 to 8 inches of the outer sheathing, making cut parallel to the wires. When outer braid is cut, be sure insulation of individual inner wires is not damaged. (See Fig. 32.)

OUTLET BOX CONNECTIONS. Outlet boxes with built-in clamps require only a turn of a screwdriver to fasten Romex securely. All boxes containing clamps have a 10/32 tapped grounding hole, in accordance with the new electrical code. Grounding screws and clips are also available. For a box having regular knockouts, use a connector (Fig. 36-D) which is fastened to the outside covering of the cable. Next, insert cable into knockout hole of box and anchor securely by screwing locknut of connector tightly from the inside. (See Fig. 34.)

NON-METALLIC CABLE WITH GROUND WIRE. Some areas require non-metallic cable with a ground wire (Fig. 36-A). Installation is similar to regular cable, but the bare ground wire must be connected solidly to the *metal* outlet boxes with grounding screws. Bakelite boxes *should not* be used.

INSTALLATION REQUIREMENTS. All bends in non-metallic cable should be gradual, and cable should be in continuous lengths from box to box. Splices (refer to Fig. 10), as for any other type of wiring, must be made inside of boxes. Use cable straps (Fig. 36-E) to support cable to joints and studdings. Cable should be anchored at 4½ foot intervals and within 6 to 12 inches of every outlet box. If wiring new buildings, use straps as mentioned above, when cable will be concealed or left exposed. In old buildings, straps are not required where cable is fished through floor or wall. (See Page 20.) Use straps for all exposed work.

PROTECT EXPOSED CABLE. Where cable is exposed, as in open ceilings or walls of basements, attics, barns, etc., it should follow some supporting surface and be given reasonable protection against mechanical injury. A practical method is to run cable along the side of a stud or joist. If cable is across or at a right angle to such timbers, it should be protected by mounting on 1 x 2 in. or 1 x 3 in. running boards, as illustrated in Fig. 33. In an unfinished basement where a flush ceiling is desired, cable may be run through holes bored in center of the floor joists. When subject to damage, cable may be protected by encasing it in conduit.

INSTALLING CABLE IN ATTICS. In wiring attics, cable can be run across top of floor joists, providing it is either mounted on a running board or is protected by guard strips mounted parallel along sides of cable. When extended across the face of attic rafters at heights of 7 feet or more above floor, protect cable the same way; otherwise, no special protection is needed. If the attic space is not accessible by permanent stairway, the running board or guard strips are required only within 6 feet of entrance. Never take short cuts across free space; always follow approximate contour of building.

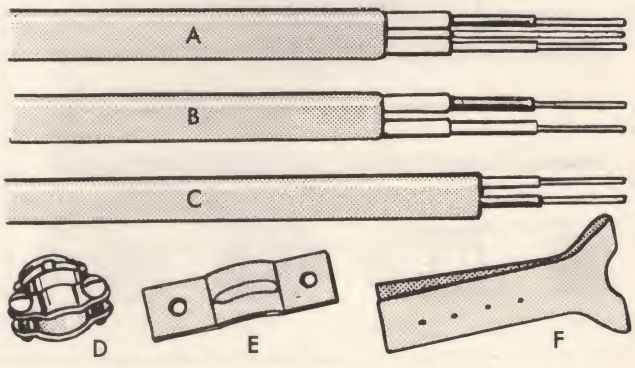


FIG. 36—NON-METALLIC CABLE COMPONENTS

TESTING WIRING. *After wiring is installed, it should be tested before power is connected. (See Page 38.) Follow procedure for grounding system as described on Page 31.*

HOW TO INSTALL Thin-Wall.....

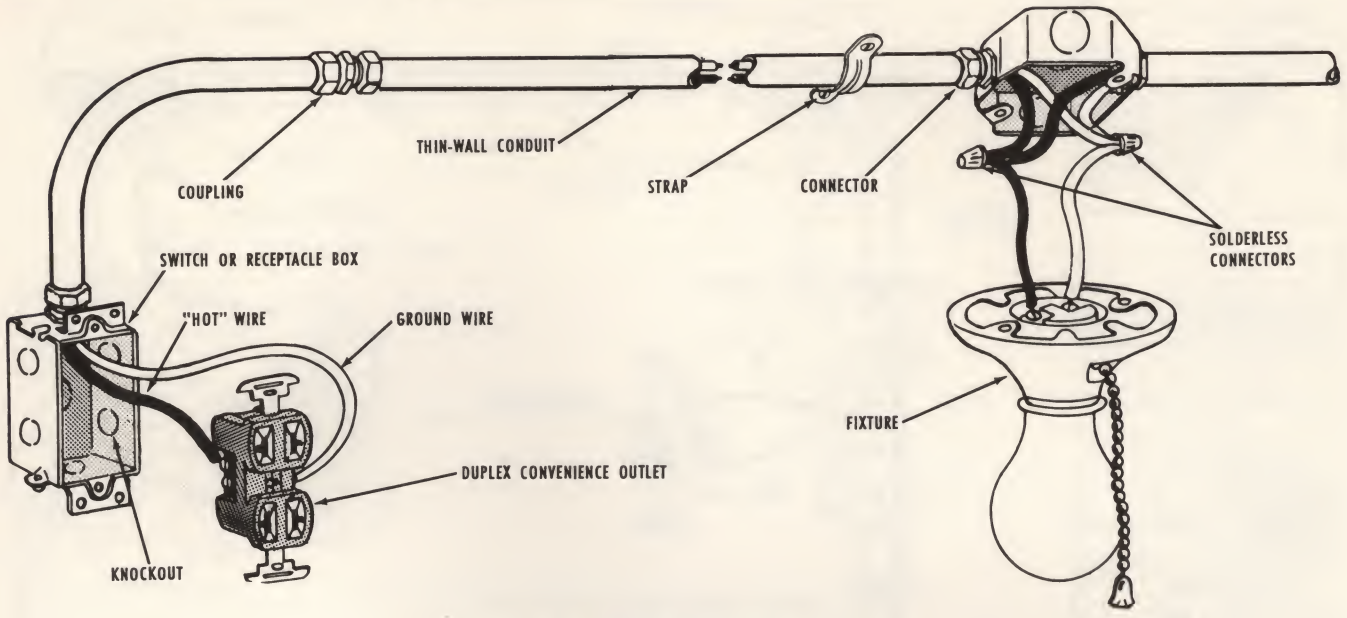


FIG. 37—CONDUIT INSTALLATION

Thin-wall conduit, also called electrical metal tubing or Type EMT, is described on Page 6 (Fig. 5). Available in 10-foot lengths, it couples together and connects to boxes with threadless, pressure-type fittings. A continuous ground is provided by the conduit. Like BX, use *only* with steel outlet boxes—never with Bakelite types, as these would break the ground.

USING A CONDUIT BENDER. Fig. 39-A illustrates a bending tool which provides the easiest and most convenient way to bend conduit. Make bends gradual, taking care not to kink or collapse the conduit, so wires can be pulled through easily. No more than four quarter bends or the equivalent should be made on any conduit run, since the fewer the bends, the easier it is to pull the wires through. Bends are most easily made by placing the conduit on the floor, as shown in Fig. 39-C.

In the course of installing conduit, obstructions will be encountered which will necessitate the bending of the conduit to suit individual conditions. Bending conduit will also be necessary at the entrance switch and for offsetting around beams or posts, etc. Fig. 40 illustrates how three 90° bends could be made to offset around a beam. Offset measurements can be taken in advance of making bends and, after bends are completed, conduit is placed in position. (90° elbow connector fittings can be used when shorter turns are required.)

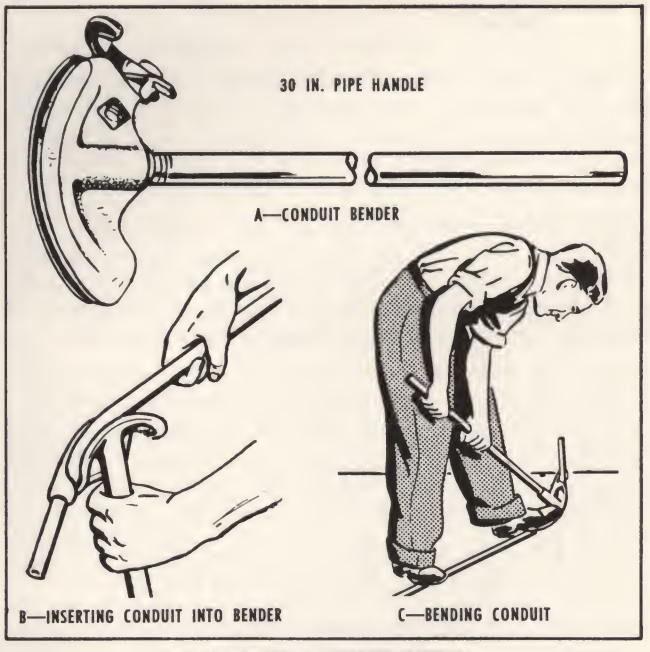


FIG. 39—USING A CONDUIT BENDER

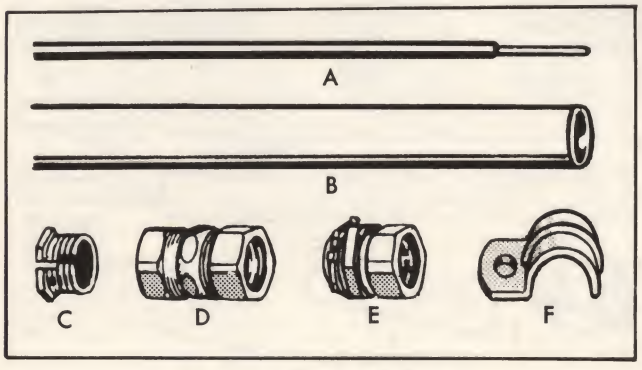


FIG. 38—CONDUIT COMPONENTS

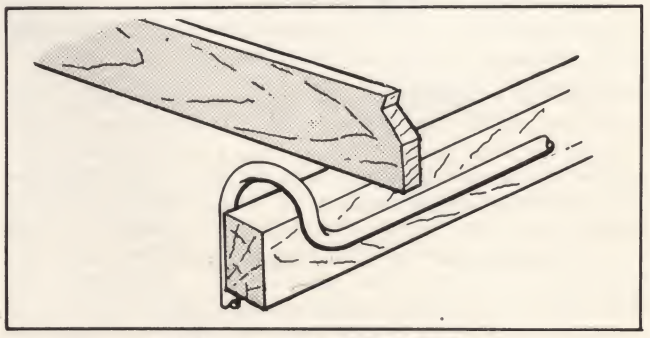


FIG. 40—CONDUIT OFFSET OVER A BEAM

TESTING WIRING. *After wiring is installed, it should be tested before power is connected. (See Page 38.) Follow procedure for grounding system as described on Page 31.*

Rigid And Flexible Conduit

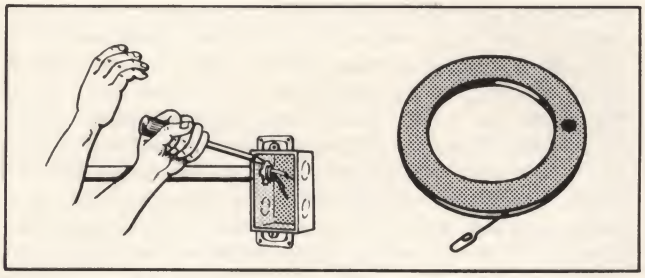


FIG. 41

FIG. 42

CUTTING TECHNIQUES. Use a hacksaw to cut both thin-wall and rigid conduit, then ream cut ends to remove sharp edges or burrs which might damage wires as they are pulled through. Remove outside sharp edges with file so that fittings can slide on easily.

MAKING CONNECTIONS. Thin-wall conduit is attached to boxes with conduit connectors. (Fig. 38-E). Fit threadless end of connector over the conduit and tighten compression nut. Then insert threaded end through knockout of box and screw locknut tightly against the box from the inside (Fig. 41). A coupling (Fig. 38-D) joins lengths of conduit together. Thin-wall tubing can be connected to rigid conduit with a threaded adapter (Fig. 38-C) which should screw into a standard pipe coupling.

INSTALLATION PROCEDURE. Conduit must be mounted in place and connected to switch and outlet boxes before pulling Type TW color coded wires (Fig. 38-A) into it. On new work, wires are usually pulled through after plastering is completed, but for "old," or remodelling work, this can be done at any time. Wires must be continuous inside conduit; make splices and connections *only* inside boxes. Anchor conduit to surface with a pipe strap (Fig. 38-F) every 6 feet on exposed runs; use strap every 10 feet on runs that will be concealed.

INSERTING WIRES INTO CONDUIT. Pull wires through conduit by means of a fish tape. (See Fig. 42.) This is a special stiff, but flexible, flat wire which can be pushed around corners easily without buckling. Fig. 43 shows how fish tape is joined to wires for easier passage through conduit. In a 2-wire circuit use one white insulated wire for the "neutral" or ground and one black for the "hot" wire. In a 3-wire circuit include a white, a black and a red wire. Where the run is short and has only one or two gradual bends, insert wires at one end of conduit and push them through to the next outlet. *All wires that are to be in any one conduit should be pulled through at the same time.* Allow 8-inches of wire at each box for making connections. Test wiring system as outlined on Page 38. Grounding provisions are explained on Page 31.

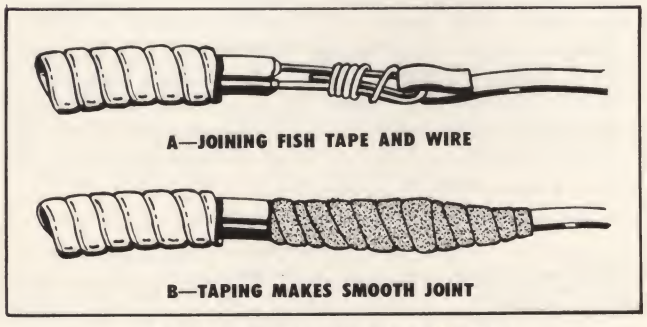


FIG. 43—CONNECTING FISH TAPE AND WIRE

RIGID CONDUIT WIRING SYSTEM. The sizes and dimensions of rigid conduit (Fig. 6) are the same as standard steel pipe, but conduit is especially annealed to permit easy bending. The inside surface is made smooth so that the wires can be pulled through it with a minimum of effort and without damage to the insulation. Cut and thread rigid conduit with the same tools used for water pipe. Rigid conduit is supplied with a black-enameled (used indoors only) or galvanized finish. Except for the use of threaded connectors and bushings, the installation procedure and code requirements are similar to that for thin-wall conduit, as explained on Page 16. Rigid conduit can be purchased at Wards retail stores.

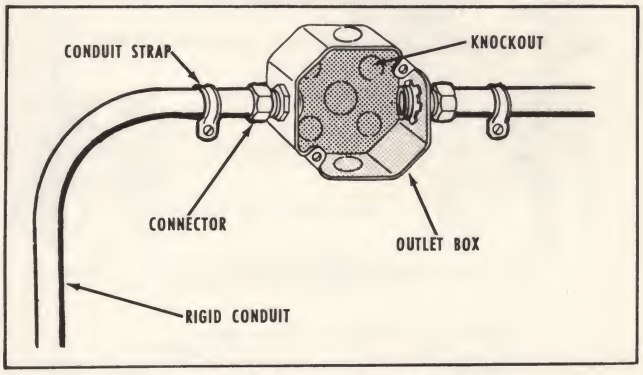


FIG. 44—RIGID CONDUIT WIRING SYSTEM

FLEXIBLE CONDUIT WIRING SYSTEM. Generally called "Greenfield," flexible conduit is similar in appearance to the protective steel casing of armored cable, but larger in diameter to permit wires to be pulled through. (See Fig. 7.) Although not universally used for general household wiring, Greenfield is an excellent material for jobs where flexibility is required or, where other conduit would not be suitable. For example, the concealment of either rigid conduit or thin-wall conduit in a finished frame partition would require the removal of a considerable amount of lath and plaster. Greenfield conduit can be easily inserted through a small hole. Often, the only openings required will be those used later for the outlet boxes. Where used for house wiring, Greenfield is installed and used like armored cable, except that wires, as with other kinds of conduit, are pulled through later. (See Fig. 45.)

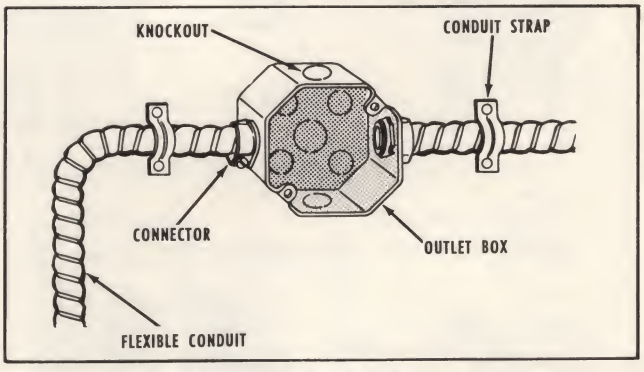


FIG. 45—FLEXIBLE CONDUIT INSTALLATION

NOTE: Greenfield conduit is available at some Wards mail order houses and retail stores.

GROUNDING PROCEDURE. *As a safety precaution, all electrical systems, and some electrical equipment, should be grounded as described on Page 31.*

HOW TO INSTALL Plug-in Outlets .....

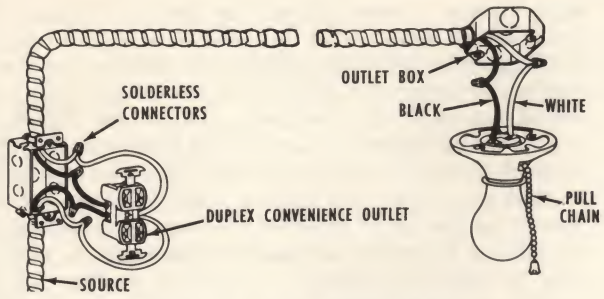


FIG. 46—PLUG-IN OUTLET ON EXISTING RUN

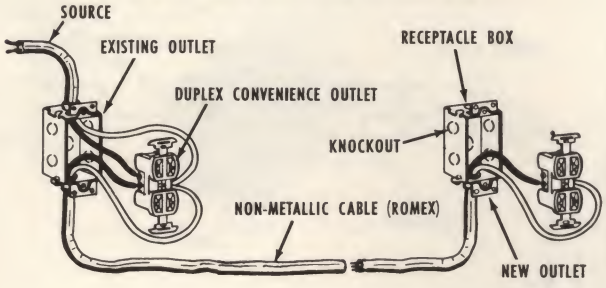


FIG. 47—PLUG-IN OUTLET ADDED

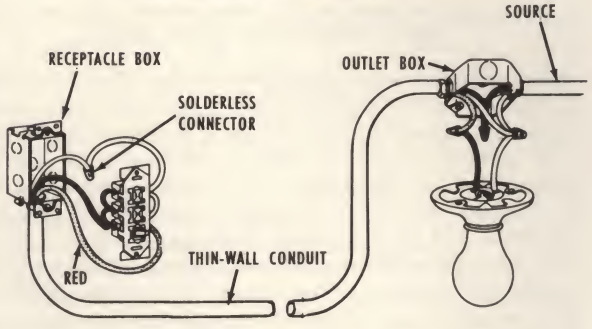


FIG. 48—SWITCH AND OUTLETS ADDED TO CEILING LIGHT

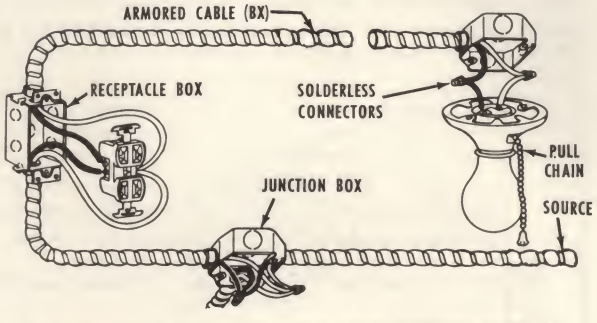


FIG. 49—OUTLET AND LIGHT ADDED FROM JUNCTION BOX

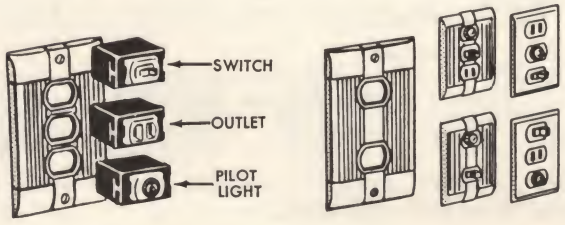


FIG. 50—INTERCHANGEABLE DEVICES

BLACK AND RED WIRES—"HOT"; WHITE—"NEUTRAL." One current-carrying "hot" wire and one "neutral" wire must run to every 115 volt current-consuming device. With 2-wire cable, the black wire is "hot"; using 3-wire cable, black wire and red wires are "hot"; the "neutral" wire is always white. To trace current flow, consider wires running from previous outlet as the source and imagine that electricity flows over the "hot" wires, through the current-consuming device and back to the source over the "neutral" wire. "Neutral" wires should always run to current-consuming devices without interruption by a switch or fuse; only "hot" wires are attached to switches. Join black wires to black or red wires—never to white, except at switch loops in cable installations where white wire should be painted black at both ends. (See Fig. 54 on Page 19.) At outlets, connect "hot" wires to dark (brass colored) terminals and white wires to light (silver colored) terminals.

INSTALLATION IN MIDDLE OF EXISTING RUN. Plug-in outlets are easy to install. Select outlet location and prepare opening for the outlet box. Next, tap into existing run with the use of short lengths of wire and screw on solderless connectors as shown in Fig. 46. Connect white wires to light-colored terminals of the receptacle and black wires to dark-colored terminals on the opposite side. Notice in illustration that receptacle will always be "on" as pull-chain will operate light only.

ADDING MORE PLUG-IN OUTLETS. For modern wiring, it is recommended that there be at least one plug-in outlet every 6 feet along the baseboard in the living room, bedrooms and other general living areas so that an extension cord is never needed. Wiring from one plug-in outlet to another is easy. (See Fig. 47.) Install extra outlets with 2-wire, non-metallic sheathed or armored cable, or two wires in conduit. A handy "plug-in strip" (Fig. 51) provides as many outlets as desired. It mounts above baseboard, over countertop in kitchen, in work shop, etc. *Do not load beyond capacity of circuit.*

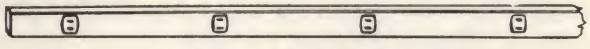


FIG. 51—PLUG-IN STRIP WIRING

COMBINATION DOUBLE OUTLET—SWITCH UNIT. Where practical, a combination wall switch and double plug-in outlet affords greater convenience when added to an existing ceiling light. Use conduit or 3-wire cable. Tap into white "neutral" wire running to fixture and connect to light-colored terminals of plug-in outlet; disconnect black "hot" wire from fixture and run to each of 3 brass-colored terminals. (Note Fig. 48.) Run red wire from remaining terminal on switch to black wire of fixture. Switch controls light only; convenience outlets are always "on".

ADDING A PLUG-IN OUTLET AND PULL-CHAIN LIGHT. Fig. 49 shows how installation can be made when the junction box is under floor (as in basement below) and outlet is to be located on floor above. Use 2-wire non-metallic sheathed or armored cable, or conduit with 2 wires. Remove the cover of junction box as shown. At plug-in outlet, connect black wire to brass-colored terminals and white wire to silver-colored terminal. Connections from receptacle for pull-chain light are the same as for installation in Fig. 46. NOTE: Pull-chain operates light only; plug-in outlet is always "on".

USING INTERCHANGEABLE DEVICES

Interchangeable devices, shown in Fig. 50, permit greater flexibility and convenience in electrical installations. Two or three devices can be assembled in one standard switch or outlet box and mounted into the same wall plate. Devices include switch, outlet and pilot light assembled in any combination or order.

CAUTION: *No electrical outlet or switch should be located at any point within the reach of a person standing in a bathtub.*

..... and Toggle Switches

WALL SWITCH FOR EXISTING LIGHT FIXTURE. This installation is suitable when the convenience of a wall switch is desired . . . where there is no switch, or when the pull-chain switch is to be replaced. Fig. 52 shows how to run conduit and two black wires from the light to the point where switch is to be located. If 2-wire non-metallic or armored cable is used, paint the white wire of the cable black at both ends, because it will actually be "hot". Inside the ceiling outlet, disconnect the black "hot" wire from the fixture and connect to wire running to the switch. Connect other wire from switch to black fixture wire projecting from the outlet box. Notice that the neutral (white) wire is not interrupted.

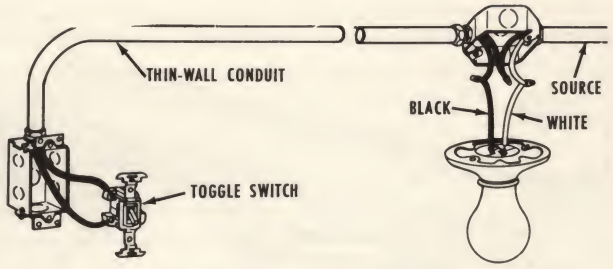


FIG. 52—SWITCH ADDED FOR EXISTING LIGHT

TWO LIGHT FIXTURES—ONE ON WALL SWITCH. Fig. 53 illustrates how two light fixtures may be on the same line, but only one light is operated by the wall switch. An "old work" example of this hook-up would be in a bedroom where a pull-chain closet light is added to an existing ceiling light. This can be done more conveniently with non-metallic or armored cable; conduit is more suitable for "new work." Run 3-wire cable from switch box to first outlet; extend two-wire cable from first to second outlet. White wire goes from switch box to both fixtures, as shown. Red wire comes from one terminal of switch and connects to black wire at first fixture. Connect black wire from other switch terminal to black wire from second fixture.

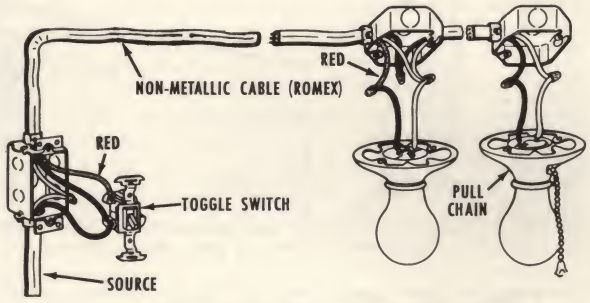


FIG. 53—TWO FIXTURES INSTALLED ON SAME LINE

SWITCH TO OPERATE CEILING FIXTURE. Cable is commonly used when adding a switch to operate a ceiling fixture. This hookup is a typical example of how black wire may be hooked up to white. This circuit is continuous through the ceiling light to other outlets. This incoming neutral (white) wire runs directly to the outlet, as usual, and continues to other outlets. The incoming black "hot" wire is tapped off to white wire of cable from switch. The black wire of this cable must be connected between the other terminal of switch and black fixture wire. (See Fig. 54.)

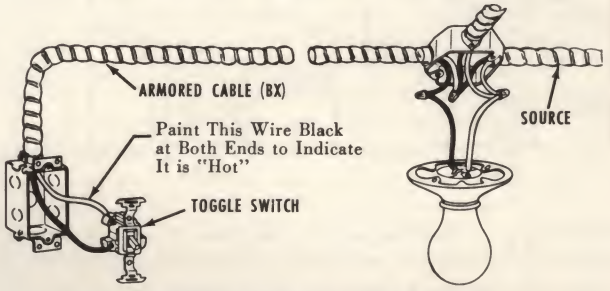


FIG. 54—SWITCH ADDED FOR CEILING FIXTURE

"3-WAY" SWITCH HOOK-UPS. To save steps or to help avoid accidents in unlighted areas, it is desirable to have the light controlled from two separate points, such as a hall or basement light from upstairs and downstairs. For this purpose two "3-way" switches are used. Fig. 55 shows how connections are made with 3-wire cable. Run the "neutral" (white) wire from source directly to the light fixture. Connect the black wire from source to the "common" terminal at point "A" of first switch. Note that the common terminals of "3-way" switches are generally at top or side and that they usually have a darker color than the others. At second switch, connect black wire of cable to the common terminal "B"; the other end is connected to black wire of light fixture. Two terminals (C and D), so far, are unused at each switch. Next, join red wires together in light fixture box and connect to terminals "C" on each switch. Connect black wire at "D" of first switch and join to white wire in fixture box which is connected to "D" at second switch. Paint wire black to indicate it is "hot". Two switches and outlet can be hooked up in many possible combinations, depending on where the source wires come in.

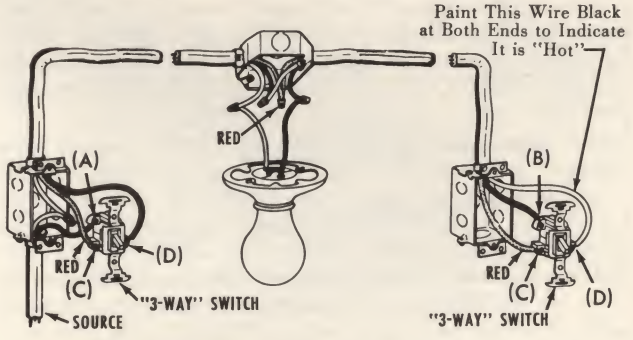


FIG. 55—"3-WAY" SWITCH INSTALLATION

"4-WAY" SWITCH HOOK-UPS. Fig. 56 illustrates how a Wards 4-Way switch is installed in conjunction with two 3-Way switches, so light may be controlled from 3 or more points.

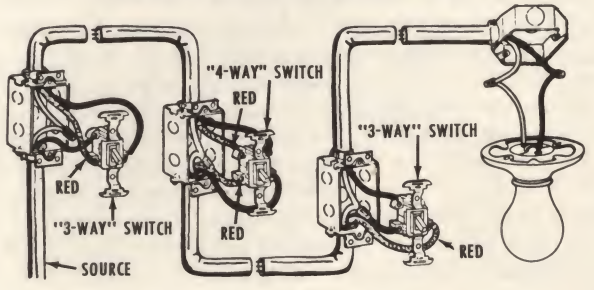


FIG. 56—"4-WAY" SWITCH INSTALLATION

CAUTION: *No electrical outlet or switch should be located at any point within the reach of a person standing in a bathtub.*

HOW TO INSTALL Switches and.....

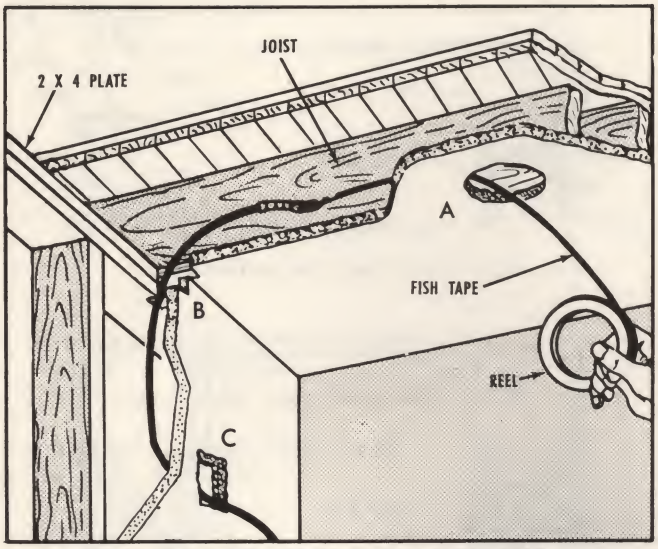


FIG. 57—"OLD WORK" CEILING TO WALL INSTALLATION

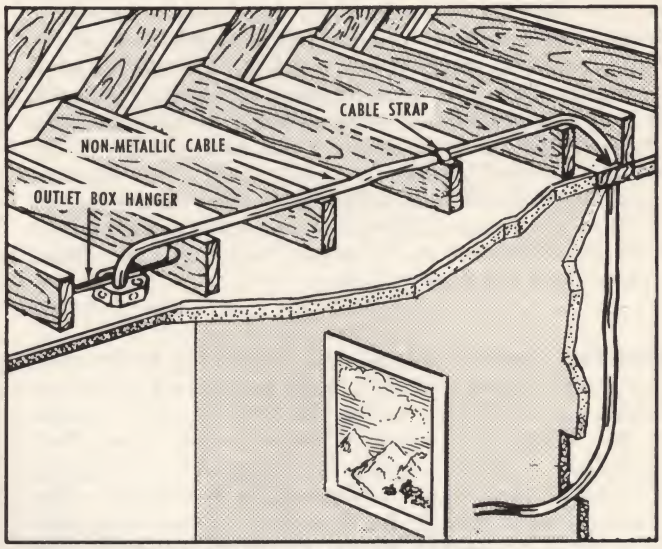


FIG. 58—RUNNING CABLE THROUGH ATTIC

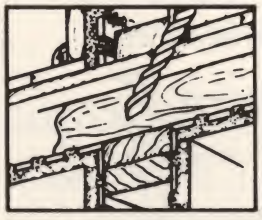


FIG. 59

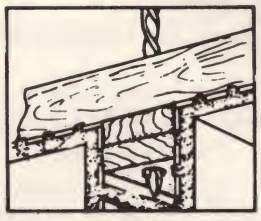


FIG. 60

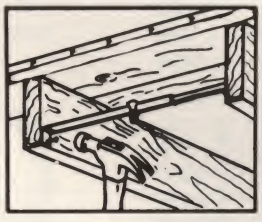


FIG. 61

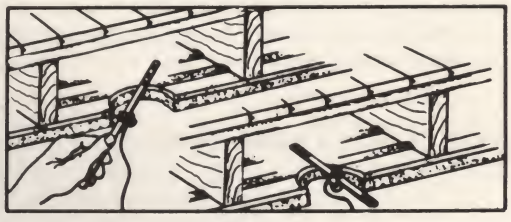


FIG. 62

The wiring of buildings after they have been completed is known as "old work"; the wiring of buildings while they are under construction is "new work". Applying the wiring methods described in previous instructions, "new" work consists of running wires along a direct route to a series of outlets and boxes. Most installation points are easily accessible. Some local codes require the use of conduit for "new" work. If conduit is used, it is installed before walls of house are completed, and wires are pulled through after plastering.

"OLD" WORK REQUIRES "FISHING". In general, there is little difference between "old" and "new" types of wiring systems, except that in "old" work more cutting and patching is involved. The problem is to prepare openings to fish wires through walls and ceiling with the least effort and minimum disturbance to the building. Because actual construction varies, every job will be different. Sometimes, by moving an intended outlet or switch to another point, a difficult boring or fishing operation can be avoided. Non-metallic or armored cable material is preferred for "old" work because it is flexible, requires little space and may be easily fished through small openings.

CEILING TO WALL CABLE INSTALLATION. Fig. 57 illustrates a typical problem of running cable from an outlet in ceiling at A around the corner through B to an opening in wall at C for a toggle switch. At B, where wall meets ceiling, there is usually a double 2 x 4 wooden plate that blocks passage of cable. At this point the usual procedure is to make a temporary opening in the plaster. An opening is then notched in the 2 x 4's with a chisel to provide a channel for fishing the cable through. After wiring is installed, the opening can be patched with a ready-mix plaster. See Page 21 for instructions on preparing an opening for a wall switch.

HOW TO FISH WIRES. After preparing necessary openings, draw the cable through by using fish wire, as shown in Fig. 57. Insert a continuous length of fish wire at A, run to opening at B and push down to side wall opening at C. Then hook and tape cable to the fish wire (Fig. 43) and pull through from opposite end until cable reaches ceiling opening. Allow about 8 inches of cable to project at points A and C for connections.

CABLE IN ATTIC. In wiring single-story houses or on the second floor of two-story houses, cable can be run through attic, if it is accessible (Fig. 58). Boards of rough attic floor can be lifted and holes drilled through wooden members, as in Fig. 60.

ENTRY THROUGH BASEBOARD. It may be necessary to run cable from an accessible opening on second floor to first floor. Where the second floor partition is directly over first floor partition, it is usually simple to bring cable through from floor above by removing baseboard and boring hole through floor and the 2 x 4 plate (Fig. 59). Later, baseboard can be replaced.

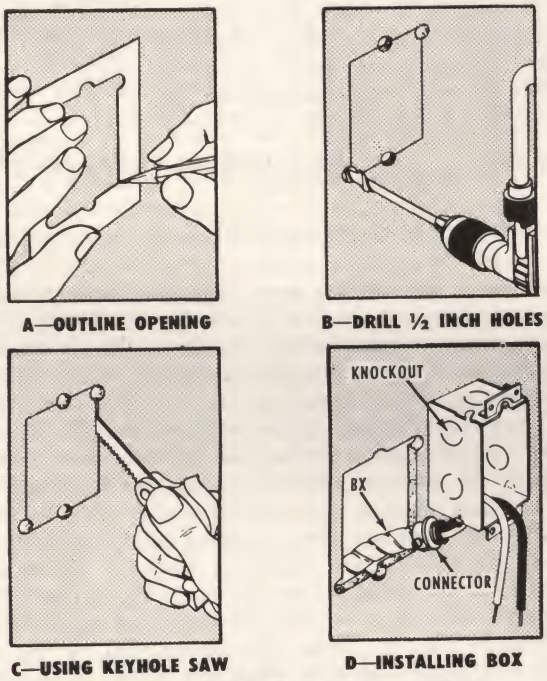
CEILING BOX INSTALLATION. Whenever possible, use at least a 1½-inch deep ceiling outlet box, although shallower types may be used when space is limited. In "old" work, where installation space is usually not accessible from above, work must be done from below.

Cut an opening in the ceiling the size of the outlet box and insert a straight-type bar hanger into opening, as shown in Fig. 61. If depth of box is greater than thickness of lath and plaster, bend an offset in the bar to raise face of box flush with plaster. If plaster is on wood laths, turn the hanger at right angles to laths so that when box and light fixture are mounted, weight will be distributed evenly. Where space is accessible, as in basement (Fig. 62), or for "new" work, an adjustable hanger or an outlet box with bracket may be used.

Receptacles in "OLD WORK"

PREPARING OPENINGS FOR BOXES. Wall switches should be placed *uniformly* about 48 to 54 inches above floor; locate "plug-in" outlets about 12 to 18 inches above floor. Wall outlets over a kitchen countertop should be about 45 in. above the floor. The preferred way is to nail boxes to studs for strong support. Studs can be located by tapping lightly on the wall.

MAKE OUTLINE OF BOX. Start by marking the approximate location of box, then drill a small hole through wall and probe with stiff wire to make sure that the box will clear the studding. If opening is clear, dig through small section of plaster to locate wood laths. Fig. 64— illustrates how the laths should be cut to support the box at top and bottom. Cut away one full lath and part sections of laths above and below. For plaster on gypsum lath construction, use box with screw type lugs, or plain box and the concealed plate with tabs. Both are shown in Fig. 66. Follow steps in Fig. 63. A—Outline actual position of box. B—Drill four ½ inch holes to provide space for keyhole or hacksaw blade. C—Cut along the outline (Hold one hand against plaster to prevent it from chipping). D—Attach cable to box with connector and locknut after box is in wall. Secure box to wall with screws or supports.



A—OUTLINE OPENING B—DRILL ½ INCH HOLES

C—USING KEYHOLE SAW D—INSTALLING BOX

FIG. 63—PREPARING OPENING FOR OUTLET BOX

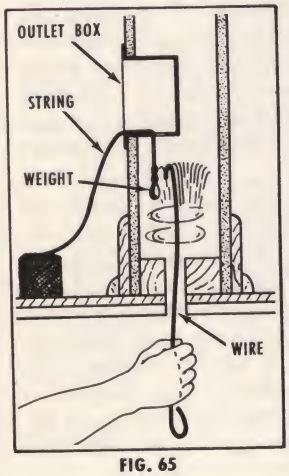


FIG. 65

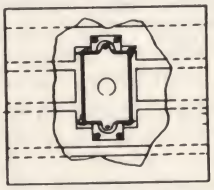


FIG. 64—CUTTING OUTLET BOX OPENINGS

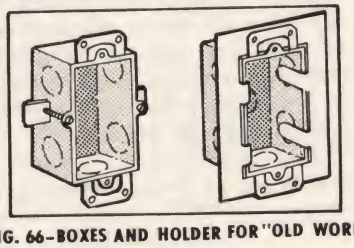


FIG. 66—BOXES AND HOLDER FOR "OLD WORK"

RUNNING CONCEALED CABLE. Study Figs. 67, 68 and 69—they show several methods of running cable from one opening to another on the same wall. The best method to follow will depend largely upon the structure of the particular building.

CABLE BEHIND BASEBOARD. When wiring from one outlet to another behind baseboard (Fig. 67), first, prepare openings, then remove baseboard. Next, cut small holes in wall (C and D) directly below the outlets. Notch a channel deep enough for a cable in the lath and plaster, or between two wood laths. Next, cut a length of cable to extend between outlets (A) and (B) and set into groove, as shown. Fig. 67 shows cable connected to boxes and wires attached to outlets. When replacing baseboard, avoid driving nails into cable.

Cable can also be run below the floor, as shown in Fig. 68 Where wall partition is accessible from basement, it is usually possible to bore a ½-inch hole directly upward between the joists. Then, fish cable up to points A and B. Fig. 65 shows how a weighted string may be pulled through the bored hole by means of a bent clothes hanger wire, even though the holes are a few inches out of alignment. Next, pull the fish tape through the openings with the string. The cable may then be easily pulled through the partition with the fish tape.

CABLE THROUGH ATTIC. Fig. 69 illustrates how cable is run through attic. Use this method where the floor boards can be lifted easily in the floor above. After cutting openings for A and B , bore holes through partition from floor above and drop cable down to receptacle openings. If necessary, use string, wire and fish tape, as previously explained.

SWITCH BOX SELECTION. Switch or receptacle boxes range in depth from 1½ to 2½ inches; use the larger size whenever possible. For "old" work, we recommend easy-to-install clamp-type box, or the regular box and separate switch box supports (Fig. 66), either of which will hold the box firmly to any wall.

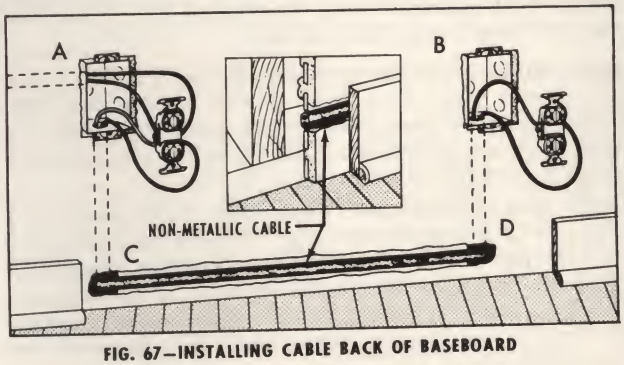


FIG. 67—INSTALLING CABLE BACK OF BASEBOARD

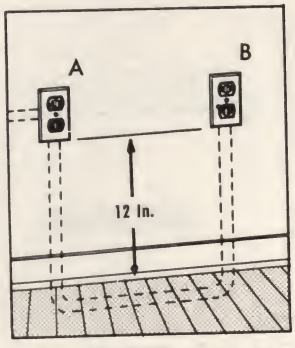


FIG. 68—CABLE THROUGH BASEMENT

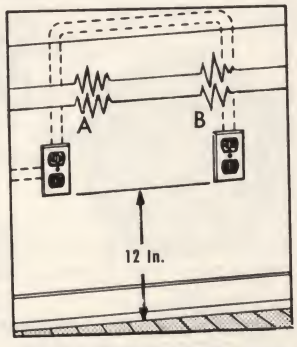


FIG. 69—CABLE THROUGH ATTIC

HOW TO INSTALL Lighting Fixtures.....

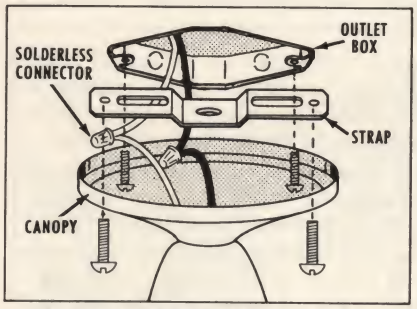


FIG. 70—CEILING FIXTURE WITH SCREWS

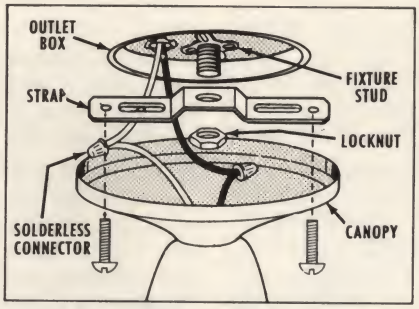


FIG. 71—CEILING FIXTURE WITH FIXTURE STUD

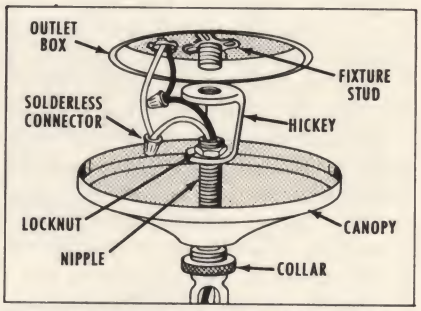


FIG. 72—MOUNTING CEILING DROP FIXTURES

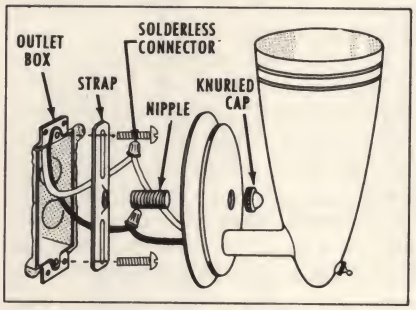


FIG. 73—WALL FIXTURE WITH SCREWS

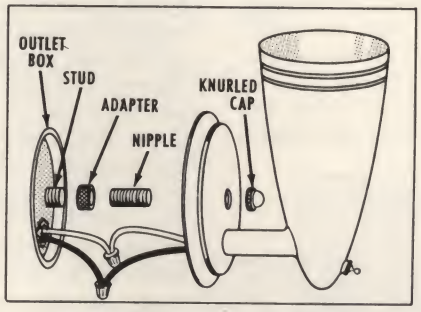


FIG. 74—WALL FIXTURE WITH STUD

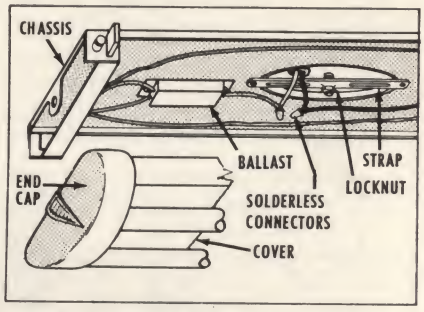


FIG. 75—INSTALLING A FLUORESCENT FIXTURE

INSTALLATION IS SIMPLE. Most lighting fixtures come prewired, ready to install. On some fixtures one wire is white; the other is black or another color. Sometimes, both wires are the same color, but one wire will have a colored tracer thread interwoven in the outer fabric. *Always connect the white wire, or the tracer wire, with the white wire in the outlet box.* There are many ways of mounting lighting fixtures. The method used depends upon the style and weight of the fixture and the particular outlet or ceiling box involved. In any case, this phase of wiring is comparatively easy.

CEILING FIXTURE MOUNTED WITH SCREWS. Fig. 70 is self-explanatory. Fasten straps (Fig. 76-D) to ears of outlet box, then make proper wire connections. Finally, attach light fixture to strap. Necessary screws, strap and solderless connectors are generally provided with this type of fixture.

FIXTURE STUD INSTALLATION. Fixture studs are frequently used for mounting heavier fixtures. Fig. 71 shows the fixture stud as an integral part of the ceiling box. However, if mounted separately, the stud is fastened to the center of the outlet box (Fig. 76-A) by bolts through holes provided for this purpose. The strap should then be slipped over the fixture stud and anchored with a locknut. Connect wires, as shown, and screw fitxure holder to strap.

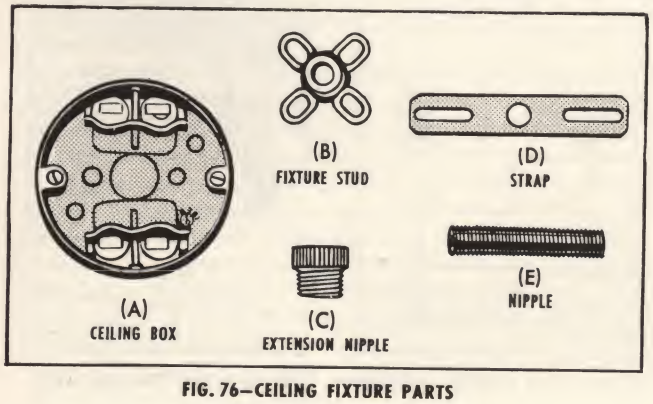


FIG. 76—CEILING FIXTURE PARTS

CEILING DROP FIXTURES. To mount a large drop fixture, a hickey or screw hanger support is used as in Fig. 72. The first step is to screw hanger support on the fixture stud (Fig. 76-B). Run wires through hickey and make connections with solderless connectors, as shown. Next, screw nipple (Fig. 76-E) into lower part of hickey and anchor with locknut. Finally, slip canopy up flush against ceiling and tighten collar. Adjustments may be made by screwing nipple further into hickey.

WALL FIXTURES. Modern type wall fixtures are often too small or too narrow in size to cover standard outlet boxes. Hence, narrow outlet boxes are frequently used for this type of fixture. The installation is simple; mount fixture strap (Fig. 76-A) directly to the box. Screw in nipple and connect wires as shown in Fig. 73. Then, place fixture over box so that nipple extends through hole and fasten fixture to wall with the knurled cap, as furnished.

MOUNTING WALL FIXTURE TO FIXTURE STUD. If an outlet box with a fixture stud (Fig. 76-B) is used, the wall fixture can be installed with either a stud adapter or an extension nipple (Fig. 76-C). Screw extension nipple or adapter (furnished with fixture) partly on to fixture stud and insert nipple into other end. Connect wires, as shown in Fig. 74, and fasten fixture to wall with knurled cap.

FLUORESCENT FIXTURES. In general, fluorescent fixtures are installed as other conventional fixtures. A typical unit consists of a chassis to which sockets, ballast and wiring are attached. End caps and metal cover (over chassis) are easily removed for making the installation. To mount, insert a fixture stud into outlet box, raise chassis and insert strap over stud and anchor with locknut as shown in Fig. 75. If stud (Fig. 76-B) is too short, use an extension nipple (Fig. 76-C). Connect wires, as shown, then replace cover and end caps. If fixture is long and heavier than average, obtain additional support by inserting wood screws at each end into the ceiling.

Doorbells and Chimes

POWER SOURCES. Doorbells, buzzers and chimes are signal systems which operate on low voltage. Power is usually furnished through a low voltage transformer, similar to Fig. 77-C. The transformer is a device that reduces the regular 115 volt alternating current to lower voltage. Doorbells and buzzers usually require 10 volts, and chimes operate on 16 volts. Because of this low voltage, heavy wire is not required; No. 18 bell wire is most commonly used. (See Fig. 77-B)

INSTALLATION TECHNIQUES. Doorbells and chimes are easy to install. The transformer is usually mounted on an outlet box in the basement or utility room. The two "primary" lead wires are permanently connected to the 115 volt line. The two "secondary" screw terminals are used for the low-voltage bell wire connections. Mount doorbells or chimes where desired. Bell wire may run over exposed surfaces, behind baseboards, under mouldings or fished through walls without further protection. Use insulated staples for anchoring wire to walls or other surfaces.

To trace current flow, consider the transformer as the source, pushbuttons as switches and the doorbells or chimes as outlets. When pushbutton is pressed, contact is made to complete the circuit, and the device will operate. When pushbutton is released, the circuit is broken and flow of current is stopped.

DOORBELL AND BUZZER HOOK-UPS

DOORBELL AND BUZZER. A buzzer for the back door and a bell for the front door are usually included on the doorbell-buzzer circuit, through the same transformer. Run wires from one of the transformer terminals to each pushbutton. Next, connect bell and buzzer to respective pushbuttons. Finally, run wire from second terminal of transformer to bell and on to buzzer as shown in Fig. 78. The system is now ready to operate. Each pushbutton will operate its corresponding device only.

COMBINATION DOORBELL-BUZZER. The buzzer for the back door and the bell for the front door can be combined into one unit operating on the same circuit, as shown in Fig. 79. The combination bell-buzzer has 3 terminals. Point A shows terminal fastened directly to frame of the device which is connected to the transformer. The two remaining terminals go directly to the pushbuttons. Connect wires as shown; Fig. 80 shows installed view.

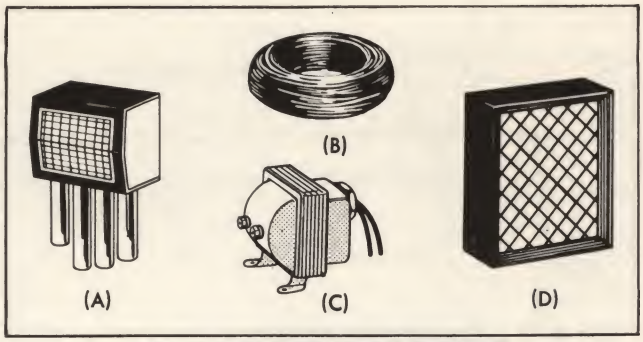


FIG. 77—WARDS DOOR SIGNAL EQUIPMENT

HOW TO INSTALL MUSICAL CHIMES

Chimes are now generally used in place of the doorbell, because of their more attractive appearance and pleasing sound. The notes are not sounded until the pushbutton is released and pressed again. Figs. 77-A and 77-D show typical Wards musical chimes.

WIRING INSTRUCTIONS. The wiring for chimes is essentially the same as for bells and buzzers. Fig. 81 shows wiring for front entrance installation of one and two-note chimes. Fig. 82 shows wiring when pushbutton for rear door is added to the same circuit. Chimes will sound one note for back door and two notes for the front door. Wards deluxe 4-tube chimes sound one note for back and 8 notes for the front door. (See Fig. 83.) Wiring instructions are included with all Wards chimes.

WIRING KITS. Wards chimes are sold with or without a wiring kit, which includes transformer, wire and two brass pushbuttons.

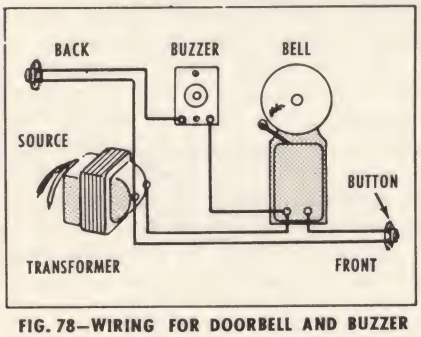


FIG. 78—WIRING FOR DOORBELL AND BUZZER

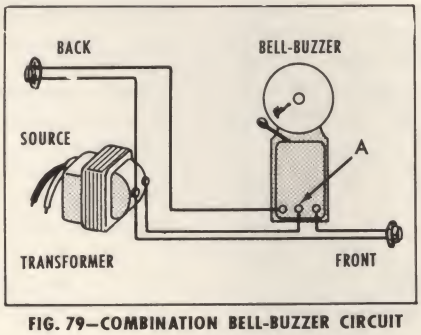


FIG. 79—COMBINATION BELL-BUZZER CIRCUIT

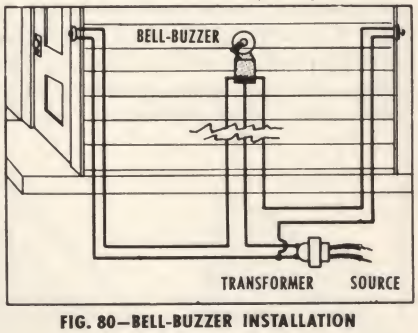


FIG. 80—BELL-BUZZER INSTALLATION

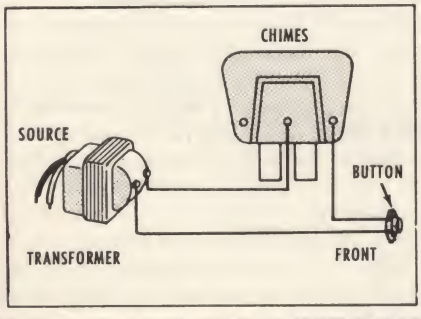


FIG. 81 1-AND 2-NOTE CHIMES AT FRONT ENTRANCE

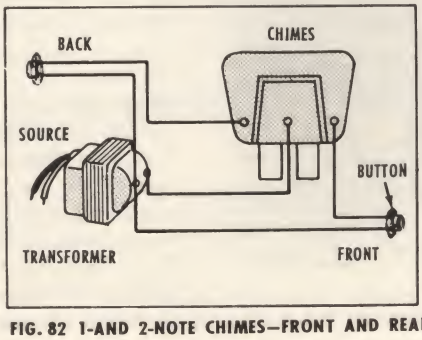


FIG. 82 1-AND 2-NOTE CHIMES—FRONT AND REAR

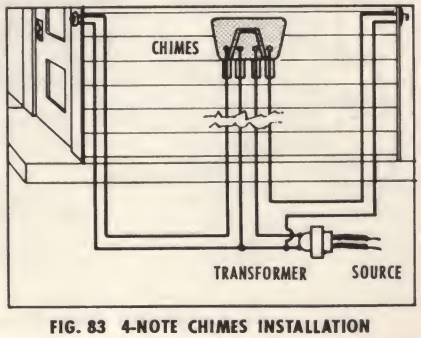


FIG. 83 4-NOTE CHIMES INSTALLATION

HOW TO INSTALL Overhead .....

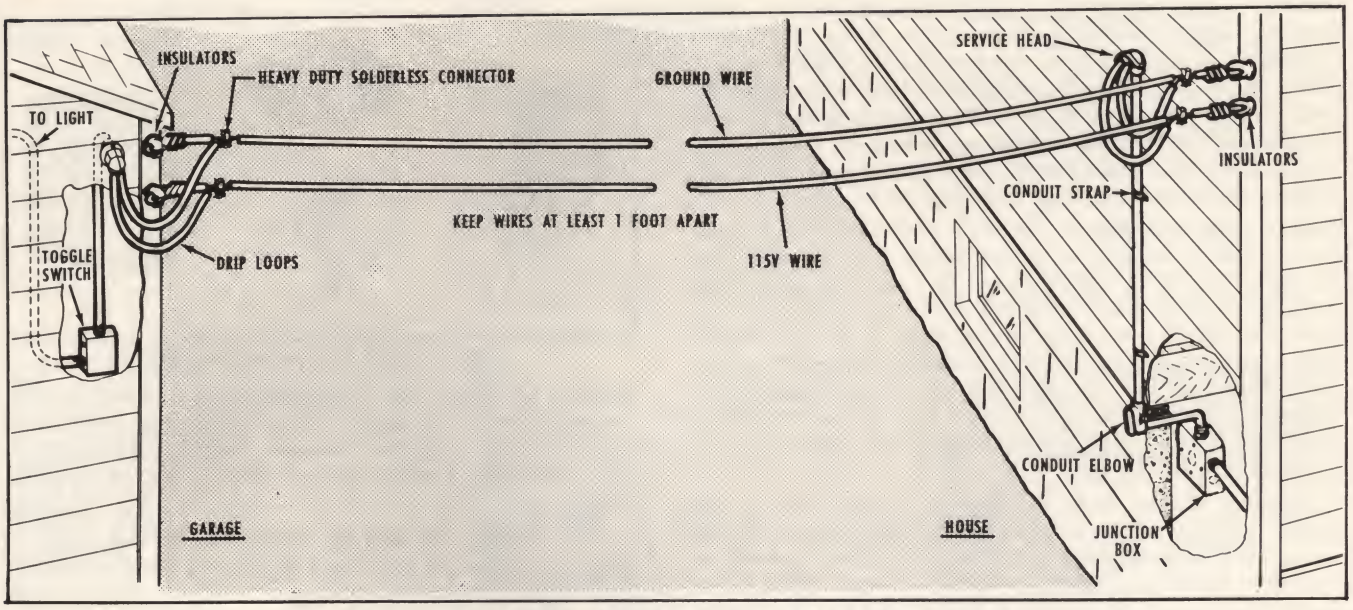


FIG. 84—OVERHEAD WIRING BETWEEN HOUSE AND GARAGE OR OUTBUILDING

WIRING FROM HOUSE TO GARAGE, BARN OR OUTBUILDINGS

Buildings requiring small electrical loads are usually served from a nearby main building, such as from house to garage in the city or between buildings on a farm. Fig. 84 shows one method of running a 2-wire service from a junction box in the house for a light in the garage. This is a simple arrangement, with only one outlet and one control switch in the outbuilding. However, for greater convenience, a 3-way switch installation is recommended. If several outlets are to be installed in the building, a fused safety switch should be used.

USING OUTDOOR WEATHERPROOF WIRE

Outdoor weatherproof wire is available with copper conductor or inexpensive aluminum conductor. In determining size wire to use for outdoor overhead installations, consider mechanical strength and current carrying capacity. (See Table II, Page 38.) The wires must be heavy enough to support, not only their own weight, but also the strain imposed by winds and snow or ice loads. Therefore, use no lighter than No. 12 weatherproof wire for spans up to 25 feet; No. 10 for spans up to 50 ft.; No. 8 up to 100 ft., and No. 6 for spans over 100 ft. When aluminum wiring is used, order one gauge heavier than for copper.

ALLOW FOR EXPANSION AND CONTRACTION. When installing wires, make allowance for expansion and contraction due to temperature changes. If installed during a cold day, wires may be pulled as tight as practical; on a hot day, allow some slack to permit contraction during winter.

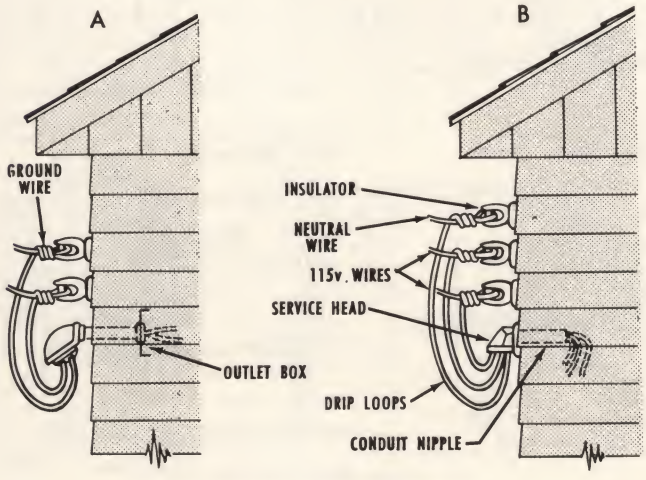


FIG. 85—BRINGING WIRES OUT OF HOUSE

BRINGING WIRES OUT OF BUILDING

Fig. 85 shows popular methods of making wiring connections outside of the house and garage or small farm building. Each method requires that drip loops be formed, so that water won't follow wire into the building. Wires should be kept at least 12 inches apart and high enough above the ground to clear any moving objects or persons. For detailed instructions on service entrance installation, see Pages 12 and 13. The number and sizes of wires to use will depend upon the amount of electric power and voltage that will be required. Fig. 85-A shows use of a service head with conduit nipple attached to outlet box with locknut and bushing. Installation of a head for 3 wires (for a 3-way switch) is shown in Fig. 85-B. Both installations require the use of porcelain insulators to support the overhead wires.

INSTALLATION WITHIN THE BUILDING

Wiring within the building will depend upon the number and types of outlets installed. The National Electrical Code provides that all wiring in the building must be capable of being disconnected by one or more switches. Thus, if one or more outlets are installed on a single circuit which is fused or protected by a circuit breaker at the main entrance switch, they may be controlled by simple toggle switches; usually, no further protection is needed. If the light is to be controlled from either of two points, as from house and garage, install 3-way switches. (See Page 19.) In this case, run 3 wires between buildings. If more than one circuit is installed, a separate entrance switch is required.

..... and Underground Wiring

Wiring between the main building and garage, barns and other outbuildings may be overhead, as explained on Page 24, but the preferred method is to place the wires underground. While this type of installation may cost slightly more, it results in a neater job and does not detract from the appearance of the property. In cold climates it eliminates the problem of strain on long spans of overhead wire imposed by winds and heavy ice loads which may permit the use of smaller wires.

TYPES OF UNDERGROUND WIRE OR CABLE

For underground wiring, use direct burial cable (lead-covered), trench wire, or plastic-covered cable, as specified by local code or utility company.

LEAD-COVERED CABLE. Fig. 86-A shows lead-covered cable, consisting of rubber-covered wires encased in a continuous layer of lead which keeps out moisture. When cable will be subjected to possible damage by passing trucks, farm animals, etc., it should be inserted in a metal conduit or plastic pipe. Make bends in conduit gradual to permit easy insertion of cable. Use one-inch conduit for either a two-wire cable (size 10, 12, or 14 gauge wires), or for 3-wire cable (size 14). Bury conduit below frost line (usually 18 to 24 inches) to prevent condensation. *Do not bury steel conduit in cinders;* the metal will deteriorate within a short time.

TRENCH WIRE. Fig. 86-B shows trench wire—a single copper conductor covered with a moisture-resistant, Neoprene outer jacket. Keep individual wires close together (use continuous lengths—no splicing), and bury at least a foot deep. It is good practice to lay lengths of board on top of these wires to serve as protection against possible disturbance from digging or gardening that may be done in the future. Wires may also be encased in steel conduit or plastic pipe. At the end of each run, wherever wire comes up out of the ground or enters the building, provide a conduit for protection, as in Fig. 87.

PLASTIC CABLE. Fig. 86-C illustrates plastic covered cable, which is tough, versatile, and insulated and jacketed with thermoplastic. It is designed especially for use underground, and may normally be buried without using conduit. This type of cable is highly resistant to mechanical damage, acids, moisture, rot and corrosion. It is excellent for underground use and for branch circuit installations. When protection is required, it may be enclosed in conduit, as previously explained. Provide fuse or circuit breaker protection, as explained under "Installations Within the Building" on Page 24. Follow the same procedure as outlined for trench wire.

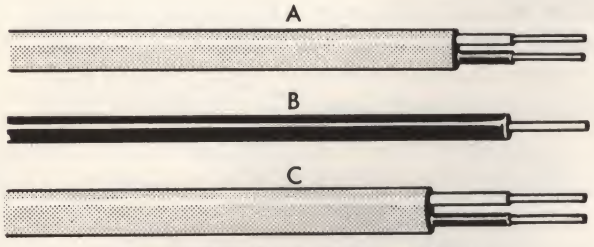


FIG. 86—UNDERGROUND WIRING MATERIALS

ENTRANCE INTO BUILDINGS

Fig. 87. illustrates underground wires extending through the foundations of two buildings. As shown, they should be run through a piece of conduit or plastic pipe for mechanical protection at both foundations. Pipe ends and the points where entrance is made into building should be sealed with a waterproof compound.

INSTALLATION WITHIN THE BUILDING

Tap into any conveniently located 115 volt junction box in the house or other main building (providing the circuit will have capacity for the additional load), and run wires to smaller structure. Wire size will depend upon length of run and number of outlets. This can be determined by reference to Table II, Page 38. Observe applicable code provisions for control switches within both buildings, as explained on Page 24. For large loads, or when more than one circuit is installed, use a separate fused switch.

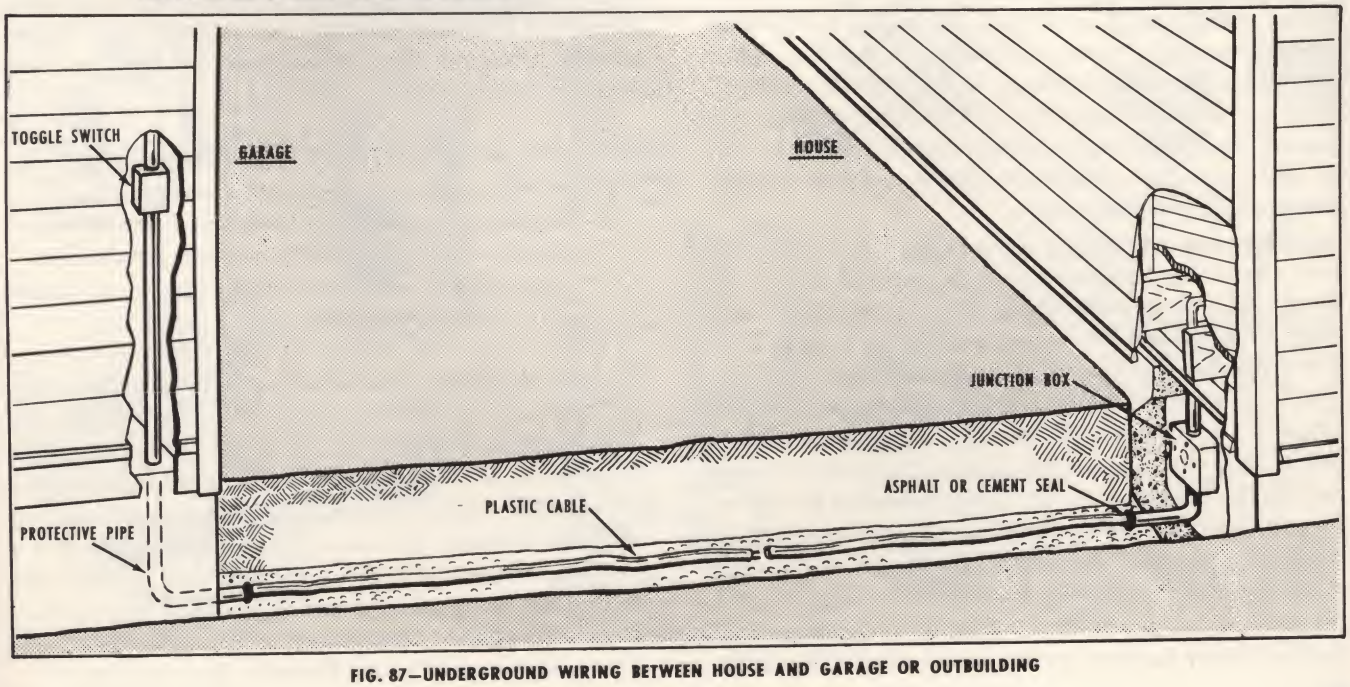


FIG. 87—UNDERGROUND WIRING BETWEEN HOUSE AND GARAGE OR OUTBUILDING

FARM WIRING SYSTEMS

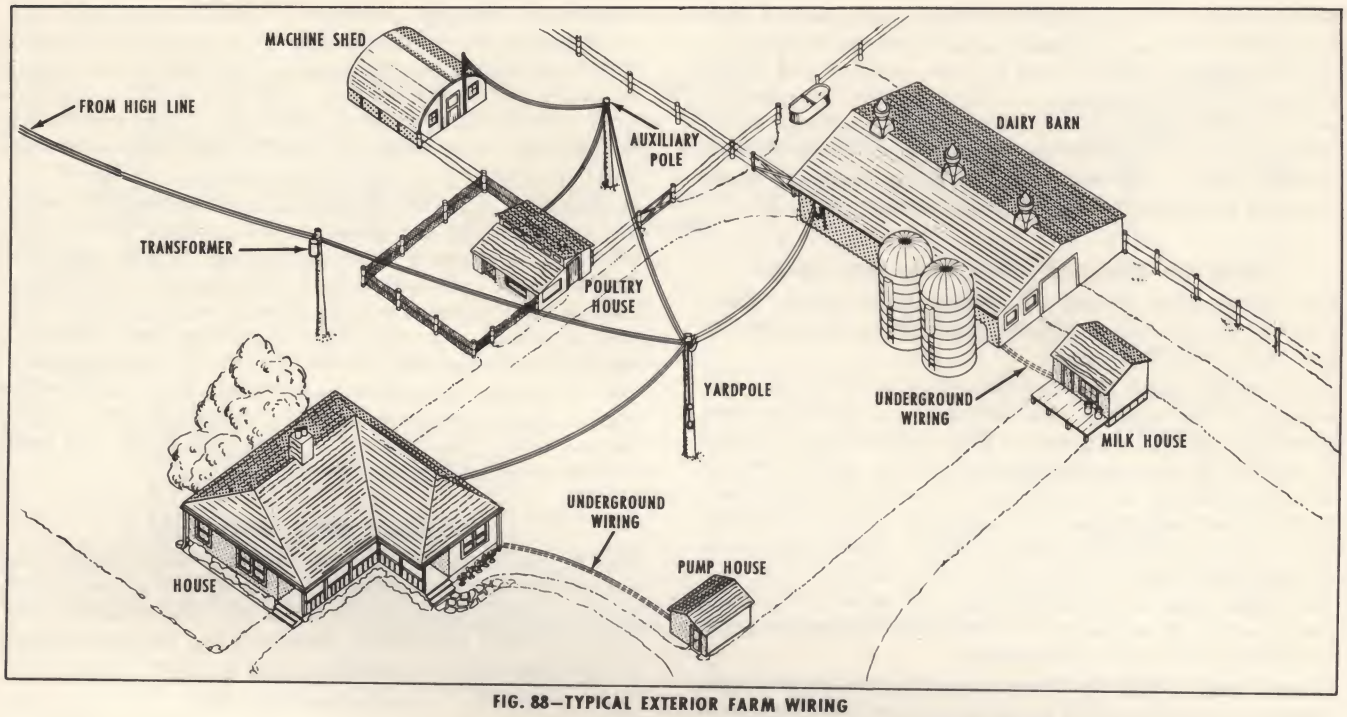


FIG. 88—TYPICAL EXTERIOR FARM WIRING

ELECTRICITY—LOW-COST WORKER

Today's farmer relies heavily upon electric power as a means for increasing efficiency and decreasing operating costs by saving time and labor. Countless chores such as pumping water, shelling corn, milking, etc., are performed by electricity for as little as a few cents a day. Many pieces of power equipment can be operated unattended, thereby relieving the operator for other work. Electric lighting, properly placed, can stretch the working day of the farmer and help eliminate accidents.

Safe, dependable and low in cost, electricity costs less per unit of kilowatt hour when more is used because rate schedules are always based on a sliding scale.

FOLLOW NATIONAL ELECTRICAL CODE. A well-planned wiring system should be designed for safety, convenience, adequate capacity, future expansion and efficiency. Safety will be assured if the standards of the National Electrical Code are observed. (See Page 2.) Careful planning will provide for future requirements. A farmer should be able to add heavy-duty equipment without making extensive changes in the wiring system.

DISTRIBUTING ELECTRICITY ON A FARM. Fig. 88 illustrates how current for a typical farm is transmitted between the home and various outbuildings. Usually, the utility company brings its power line (sometimes called the high line) to a point where it is connected to a distribution transformer from which the service wires are tapped. From this point, secondary lines conduct the current to a yardpole (or meter pole). Here the incoming lines are led through the meter which measures the amount of current consumed in kilowatt hours. Although a meter can be mounted on the outside or inside of a building, the modern farm practice is to place it on a yardpole which usually is more centrally located. From the meter, the current is conducted to a weatherproof, fused or circuit breaker type disconnect switch (Fig. 21-D).

Before the main service and exterior wiring can be planned, the needs of individual buildings must be determined. Hence, interior wiring for farm buildings should be planned to assure these important provisions:

1. *Select proper type, number required and location of switches, convenience and special outlets.*
2. *Provide enough branch and individual equipment circuits to handle present and foreseeable future needs.*
3. *Select entrance equipment with capacity to handle extra needs. (See Page 11.)*

By doing the wiring job yourself, you will effect a considerable saving, but the real savings will be achieved if the wiring system is designed with an eye on future needs. Whether you are wiring new or rewiring old buildings, the added cost in terms of time and labor invested, of installing adequate wiring at the time of initial installation is only a fraction of the cost of rewiring at a later date. Any increase needed later in the wiring system means doing the job twice. Material is wasted; labor is used to take old wire out and to put new wire in. Use the Planning Chart on Page 37.

FARM EQUIPMENT POWER NEEDS

FARM EQUIPMENT POWER NEEDS. One of the first and most important considerations in farm wiring is deciding upon a service entrance of adequate capacity. (See Page 11.) This decision should be based upon present and expected future consumption of electricity. "Automation" on the farm in the form of electrically powered equipment such as milking machines, milk cooler, water pump, etc., imposes power demands which have a vital bearing on service entrance capacity.

Several pieces of typical farm machinery which are operated by electricity, and their wattages are shown in Fig. 89, Only representative wattages are given; check nameplate on machine for actual ratings. Pages 4 and 5 illustrate home appliances and their wattages which should also be considered when calculating power load requirements. While 100 ampere service is the minimum recommended, on some farms even 200 ampere service would be inadequate. As the use of one electric "servant" leads to another, the modern farmer looks ahead 5 to 10 years when his electrical system will be overtaxed, unless ample power provisions are considered in advance. Plans should also include the possible addition of electric motors to manually-operated equipment, and the replacement of worn out or undersized motors. The selection of motors is explained on Page 33.

Order electrically-powered farm equipment from Wards Catalog, Farm Book or Wards retail or catalog store.

STAND-BY GENERATORS ASSURE UNINTERRUPTED POWER SERVICE

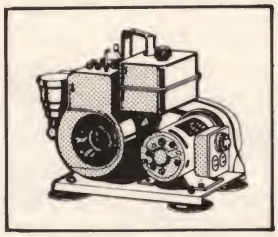


FIG. 90—UTILITY GENERATOR

As a farmer becomes more dependent upon electricity, it is essential that the power source supplying the pump, milk cooler, brooder, etc., operate without interruption. Severe storms in some rural areas result in power failures, and the farmer may be without light, refrigeration or heat for long periods of time. Where power interruptions are common, or where they could result in financial loss, a farmer should consider installation of emergency generating equipment. Wards sells manual start units (Fig. 90), also, direct-drive generators and units which operate with tractors. Capacity range is from 1250 to 4000 watts, and units should be selected on the basis of 25% larger capacity than the maximum anticipated load.

A double-throw switch should be used to connect generating equipment to the farm wiring system. This switch will disconnect the regular power service before generator is connected. Power is prevented from feeding back into the regular power service line; also, damage to the generator is prevented as power cannot feed back into it when normal service is resumed.

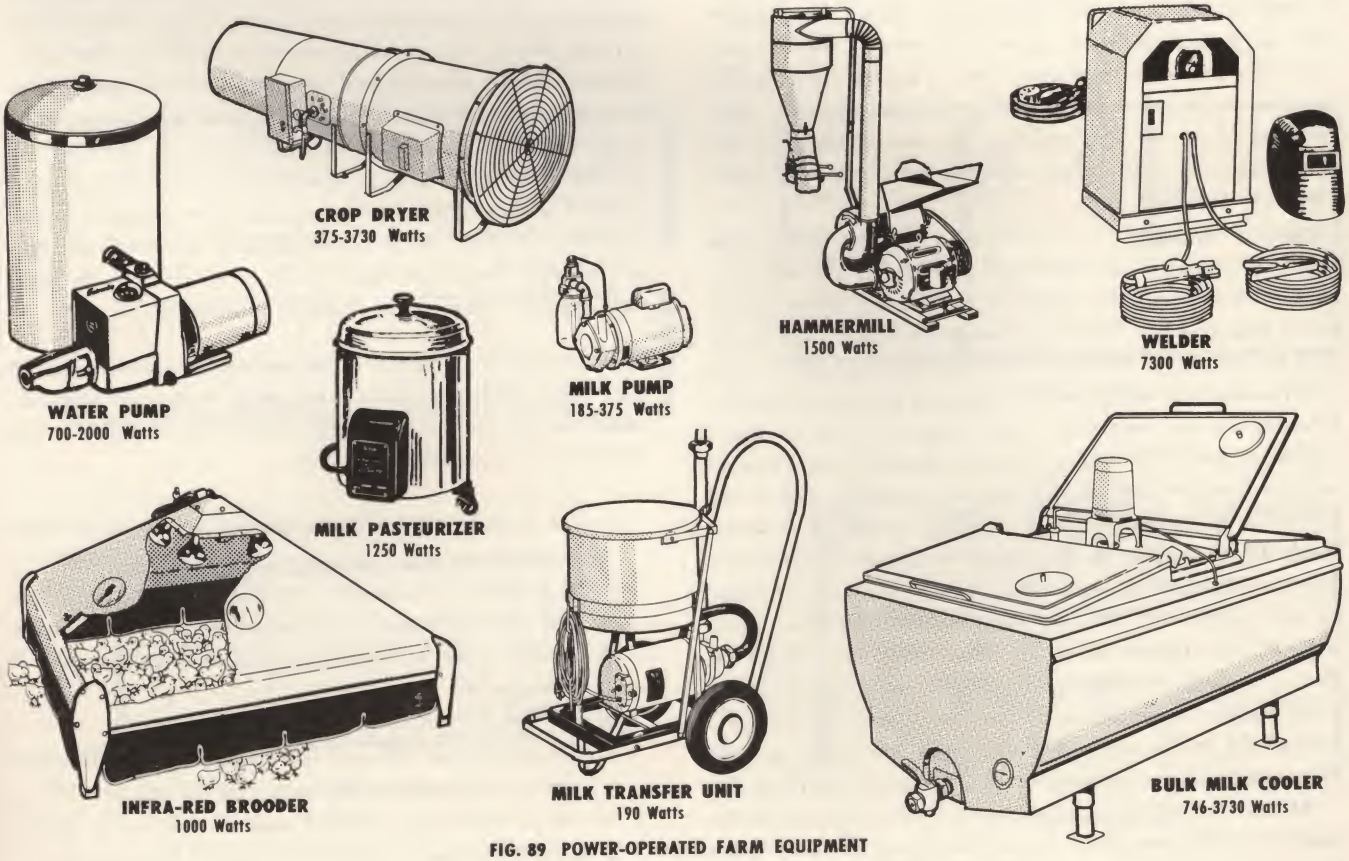


FIG. 89 POWER-OPERATED FARM EQUIPMENT

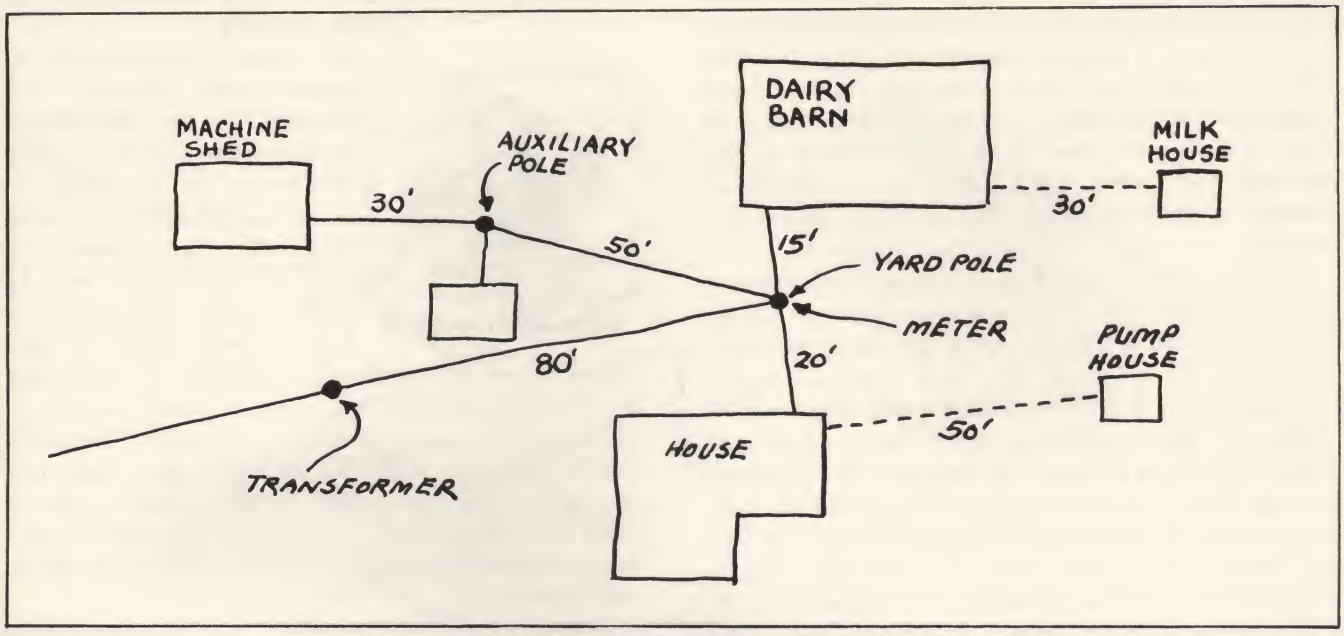


FIG. 91—DIAGRAM OF EXTERIOR FARM WIRING SYSTEM

MAKE SKETCH OF BUILDING. A correct and well thought-out wiring plan for the farm electrical installation can save many hours of work and result in lower material costs. Page 36 tells how to use the Planning Chart (Page 37) which has been provided for this purpose. By locating fixtures, outlets, switches and appliances on the sketch, the installation can be visualized on paper, and changes can be made before the actual job is started. Such a layout can be useful in determining the number of individual circuits, their electrical load and the total load for the building. It also serves as a check list when ordering materials or for estimating the job cost.

EXTERIOR WIRING. Fig. 91 shows a diagram of the farm building arrangement illustrated in Fig. 88. Show dimensions of buildings to be wired, the purpose for which each is being used and the distances between buildings. The sketch will be helpful in deciding how and where exterior wires will run and will aid the utility company in determining the location for the yardpole. Lines from pole to all farm buildings with 230 volt equipment should have 3 wires; service lines to small buildings are normally two wires tapped from a nearby large building served by 3 wires. Table III shows that as the length of circuits is increased, heavier wire must be used, due to voltage drop. In deciding on wire size needed for runs to each building, allow extra capacity for future loads. In some areas, wire must be strong enough, considering length of span, to withstand wind and the weight of ice. Where these conditions prevail, consult the utility company concerning wire sizes, or consider placing wires underground. Tables *are on Page 38.*

At each building served directly from yardpole, there must be a service entrance switch which should be of large enough capacity to handle the existing electric load, as well as that in the foreseeable future.

UNDERGROUND WIRING. Many farmers prefer underground wiring because it does not require a yardpole or wires strung overhead to buildings; also, the hazards of bad weather and ice conditions are avoided. In an underground wiring system, the meter is usually installed at the transformer. Feeder wires extend from the meter to farm buildings 18 inches or more below the ground level, depending upon the use of the land in which the wires are buried. Page 25 shows details of underground wiring methods. An underground wiring system will cost somewhat more to install than an overhead yardpole installation, but wires are concealed and last longer than overhead conductors. In addition, danger from fallen wires is eliminated.

When animals occupy a farm building, higher humidity and other conditions make it necessary to give special consideration to the wiring system. Pay close attention to the following recommendations:

1. *For buildings which house livstock, or which have two or more circuits, provide a ground. (See Page 31.)*
2. *In buildings where the humidity is high, or where acid fumes are common, install non-metallic, plastic covered cable, although non-metallic sheathed cable is also suitable.*
3. *Use Bakelite boxes with both types of cable.*
4. *Provide 3-wire 230 volt special outlets for all motor-driven equipment with motors of* ¾ HP *or over.*
5. *All permanently installed motors and motor-driven equipment, and portable tools should be grounded.*

.....for Barns and Outbuildings

FARM WIRING INSTRUCTIONS. The physical makeup of circuits in barns and other outbuildings is essentially the same as in house wiring. See Page 6 for instructions covering the installation of non-metallic and plastic cable. The exact method of installation will depend largely on the structure being wired. It is important to install cable so that it will not be exposed to mechanical damage from animals, implements, etc. Whenever possible, run cable along sides of beams and joists rather than below them. Avoid running cable at right angles across the bottom of joists. Protect cable with conduit when passing through floors.

LOCATING OUTLETS AND SWITCHES. Install lighting, convenience, and special-purpose outlets according to the use of the individual building. Fig. 92 shows typical layouts for several types of buildings. Local farm agents can usually make recommendations on outlet requirements for specific layouts.

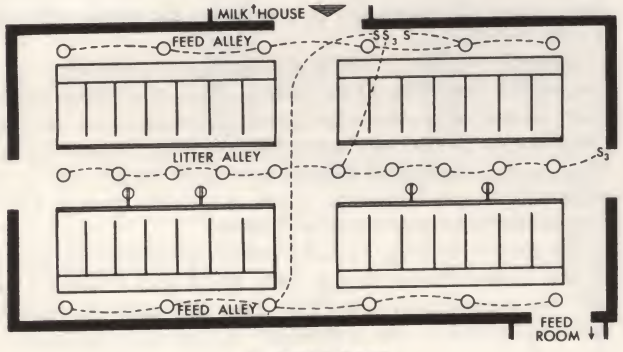
As a general rule, a good plan is to provide at least one light behind each pair of stalls. When possible, install lights between (rather than below joists) so that the bulb will be less exposed to possible damage. Each row of lights should be controlled by a separate toggle switch. For better distribution of light, equip each socket with a reflector.

Enough plug-in outlets should be installed so that equipment can be readily used without long extension cords. Locate both plug-in receptacles and switches high enough so that they cannot be touched by animals in passing. If the barn has two entrances, 3-way switches are desirable (Page 19) to control at least one light from either end of the barn. Be sure to allow for 3-wire 230 volt circuits to take care of heavy-duty equipment. On the outside of building, provide at least one grounded weatherproof plug-in outlet (see Fig. 95) to facilitate the use of motors and other equipment for outside use.

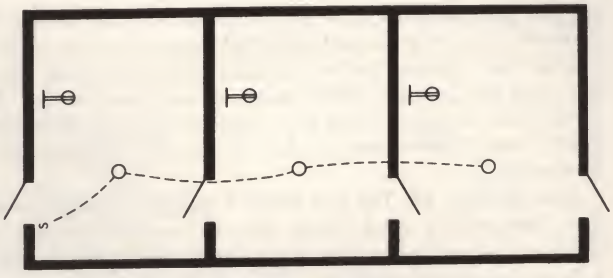
POULTRY HOUSE WIRING. Egg production, especially during winter months, can be increased by means of artificial light. Since geographic location and poultry breed influence the type of lighting selected, consult your local farm agent about specific conditions.

A ceiling-mounted outlet with a 60-watt lamp and a wide-spread reflector takes care of 200 square feet of floor area. Wards can furnish special time control switches that will automatically turn on dim-light or bright-light outlets, as required. Simply set the control for the hours desired; the lighting cycles will then be maintained automatically. Wiring for these switches is simple; follow instructions furnished with the units.

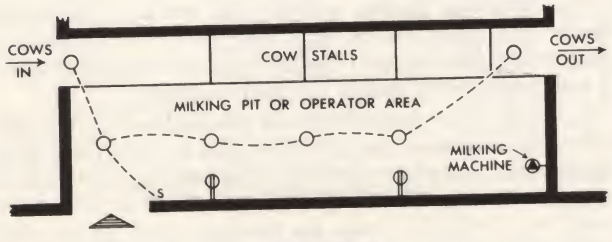
Brooders and incubators, except possibly for large commercial sizes, should be on 115 volt circuits. If it is planned to use Wards heating tape (Fig. 110), it may be desirable to provide a separate circuit, because of the increased load. Install a 230 volt circuit for feed mixer or grinder. A 3-wire service entrance with a 60 ampere entrance switch is recommended for such equipment.



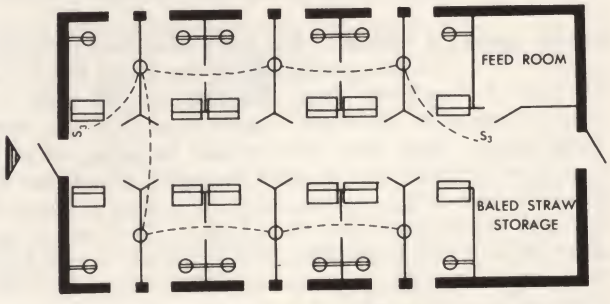
A—DAIRY BARN



B—BROODER HOUSE



C—MILK HOUSE



D—FARROWING PEN

FIG. 92—FARM BUILDING WIRING PLANS WITH OUTLET AND SWITCH LOCATIONS

HOW TO WIRE the YARDPOLE.....

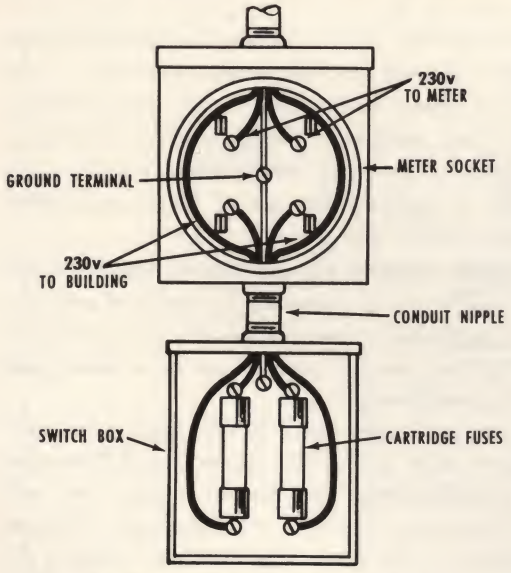


FIG. 93—SWITCH BOX-METER ASSEMBLY

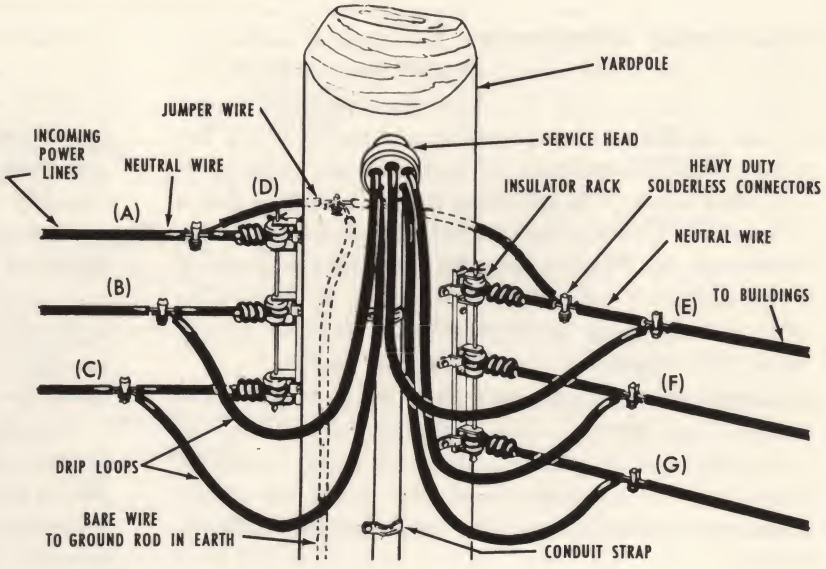


FIG. 94—YARDPOLE WIRING CONNECTIONS

PREWIRE POLE BEFORE RAISING. The yardpole (or meter pole) functions as the power distribution center to farm buildings. (See Fig. 88.) The utility company usually brings wires to the farm as far as the yardpole where the meter and a weatherproof disconnect switch are installed. This permits power for the entire farm to be shut off from one location.

If a pole is to be put in new, attach switch, meter, conduit (all wired beforehand), and insulator racks to pole before raising. This makes the job much easier than if the work is done after the pole is up. Be sure that the service head on top of the conduit comes up to a point above the neutral (top) wire.

WIRING THE YARDPOLE. Use weatherproof wire for wiring the yardpole. Be sure to use the approved wire size for the ampere load of your system. Service entrance connectors (Fig. 14-C) are used for joining feeder wires to yardpole wiring. All connections must be taped after installation and inspection. Plastic tape is recommended, but rubber and friction tape is acceptable.

Refer to Fig. 94. The hot wires B and C run from power lines into service head, down through conduit and are attached to hot wires F and G of the service drop. This requires a service head with five holes. Some local codes do not permit the running of wires *to* the meter and *from* the meter in one conduit. If this is the case in your area, two separate conduits must be installed from meter to top of pole(double stack construction). Consult your local inspector or utility company about this.

SERVICE DROPS OR "FEEDERS". The three wires from the utility company run from the transformer on the power line to the meter on the yardpole. From this point on, all wires are usually supplied by the owner. Fig. 94 shows only one set of three "feeder" wires from pole to farm buildings. More of these "service drops" can be added as needed. Attach each additional service drop to an insulator rack and tap in from two hot wires coming from meter, then connect third neutral wire of service drop to complete the job. Be sure that service drops from pole to all buildings do not contact anything except their own insulators. These wires should have a clearance of at least 8 feet over roofs along their entire length and 10 ft. above the ground.

NEUTRAL WIRE CONNECTIONS. The top wire A is always the neutral (or ground) wire. It is connected by means of jumper wire D from transformer to neutral wires E going to all buildings, through conduit to neutral poles of meter and switch, and separately down side of yardpole to ground rod.

TWO ACCEPTABLE METHODS. Two methods are in use for bringing the neutral wire down the side of the yardpole. One way is to run the jumper wire D around the pole on the side opposite the conduit and meter, as shown in Fig. 94. Tap the bare ground wire onto the jumper wire and run the bare ground wire all the way down the pole opposite the meter, attaching it with staples.

The other way is to run the jumper wire around the yardpole on the same side of the pole as the meter. Then, tap the bare ground wire onto the jumper wire and run the bare ground wire all the way down the pole right beside the conduit. Both conduit and ground wire must be secured to the pole with straps. Below the switch, staple the ground wire to the pole in the manner described above.

The exact method to be followed will usually be determined by the local utility company. Bare No. 6 wire is usually suitable for ground wire. Fig. 100, Page 31 shows how ground wire is clamped to the ground rod driven into the earth.

CONDUIT—INSULATOR RACK REQUIREMENTS. The yardpole conduit must be large enough to hold all the wires running through it. Fig. 94 shows conduit with 5 wires leading from it; this should be at least 1¼ in. pipe. The service head should be connected tightly to top of conduit. All connections of conduit to meter and switch should be tightly secured.

Insulator racks should be firmly attached near top of pole. Individual insulators that screw into pole are sometimes used; check your local utility company. Use one insulator rack for each service drop (feeder wires—a set of two or three wires going to a building)—and one insulator rack for incoming power lines. It is recommended that each rack be secured to the pole with at least one bolt and lugnut so that wires will not pull rack off the pole during storms, or due to ice conditions.

..... GROUND the Wiring System for SAFETY

If an electrical system is to be considered truly safe, close attention must be given to grounding details. The neutral wire of every electrical system is required to be grounded at some point . . . that is, it must be in contact with the earth either directly or indirectly through another good electrical conductor. Electrical equipment used where damp floors are prevalent should also be grounded. Grounding reduces the effect of accidental contact of the wiring system with high voltage or lightning.

CITY WATER SYSTEM GROUNDING. Note Fig. 99 which illustrates a city water system where a ground wire has been extended from the neutral bar of the service entrance switch and clamped securely to the nearest cold water pipe with special ground connectors. Make connections to the pipes on both sides of the water meter and install a jumper wire (No. 8 copper wire) around the meter. This arrangement assures a permanently grounded system, even though the meter is temporarily removed for repairs or other reasons.

GROUNDING THE FARM SYSTEM. A farm wiring system requires grounding at several points. The yardpole, the house, every outbuilding housing livestock and every building having two or more circuits—all must be grounded. Usually a city water system is not available, so an "artificial" ground must be installed. The ground wire is tapped off the neutral overhead wire (at the drip loop—see Fig. 94), brought down the side of the building or yardpole, and attached to a driven ground rod with a ground clamp, as shown in Fig. 100.

The rod is usually copper-clad steel and must be at least ½ in. in diameter. Locate ground rod 2 ft. from building and drive at least 8 ft. into the earth. Galvanized water pipe, if it complies with the local code, must be at least ¾-in. in diameter. Check the grounding provisions of the local code, or utility company requirements.

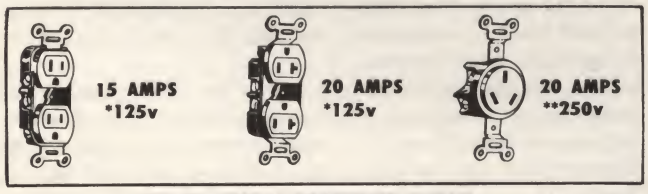


FIG. 95—TYPICAL GROUNDING OUTLETS

*Use for 115v
**Use for 230v

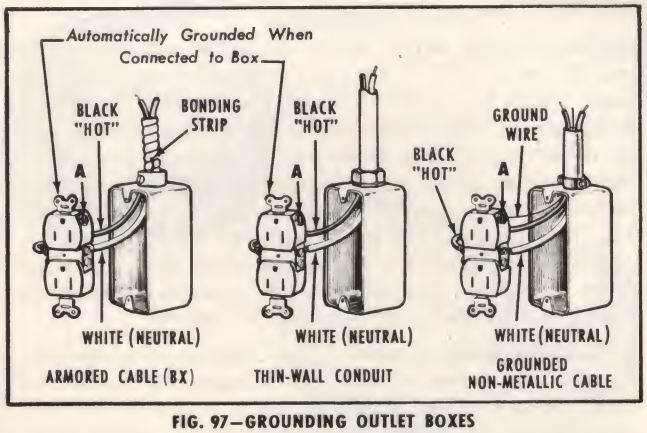


FIG. 97—GROUNDING OUTLET BOXES

DRIVING THE GROUND ROD. All ground rods must be installed permanently and protected from damage. The edge of a shovel or the chemical action of animal droppings can sever a ground wire, resulting in the development of a dangerous wiring condition. One way to install a ground connection is to drive the rod into the earth so that a couple of inches remain above grade level, leaving ground clamp permanently exposed. The other way is to dig a hole about a foot deep and drive rod into the earth, with the ground clamp covered by about 12 inches of earth. Carefully inspect ground connections before back filling.

EQUIPMENT GROUNDING. To avoid the hazard of shock it is necessary to attach a ground wire to the frames of washing machines, dryers, ironers, portable tools, etc., powered by electric motors. Fig. 98 shows how a mounting bolt on a motor anchors the grounding wire which is fastened to ground lugs on the equipment frame. Frames of electric ranges, wall-mounted ovens and counter-mounted cooking units are grounded in a similar fashion.

GROUNDED OUTLETS. Fig. 95 shows three styles of Wards 3-wire grounded outlets which help prevent dangerous shocks from appliances and motors due to faulty wiring or worn insulation. Note that outlets which have two current carrying slots and one ground slot vary in slot arrangement; this assures that the wires will always be correctly aligned. Be sure the grounded outlet matches appliance rating and plug blades.

Fig. 97 shows grounded outlets connected to grounded type cable, armored cable (BX) and conduit. These outlets are especially important when the user may stand on a damp basement or garage floor to operate laundry equipment and power tools, etc. This is also true for electrically powered mowers, because the operator stands on bare, and often damp ground.

For BX and thin-wall conduit installations, some local codes require an additional connection from the green-colored terminal screw "A" (Fig. 97) on the outlet to the metal box. Screw holes are provided in most metal boxes for this purpose. Use a piece of No. 18 ga. wire or heavier. (Check local code.)

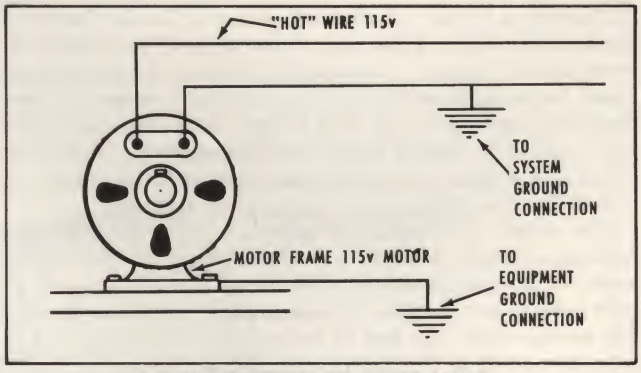


FIG. 98—GROUNDING THE MOTOR FRAME

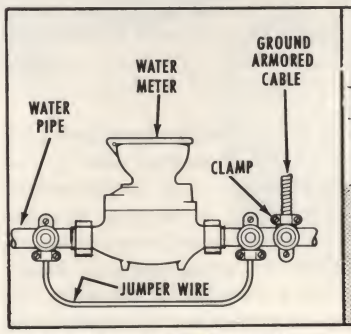


FIG. 99—CITY WATER SYSTEM GROUND

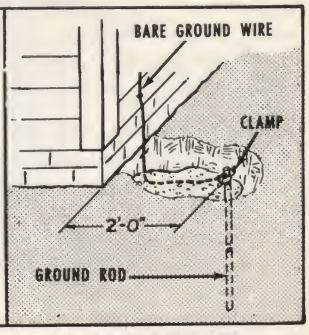


FIG. 100—GROUND ROD INSTALLATION

HOW TO WIRE 230 Volt Appliances.....

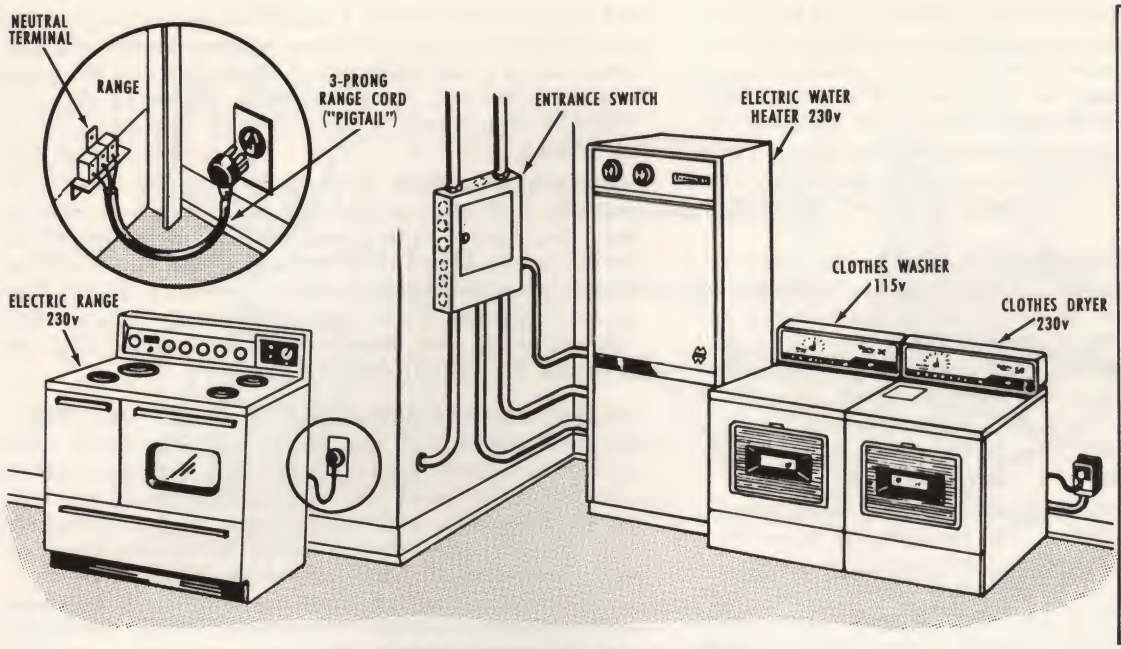


FIG. 101—WIRING TYPICAL 230v VOLT APPLIANCES

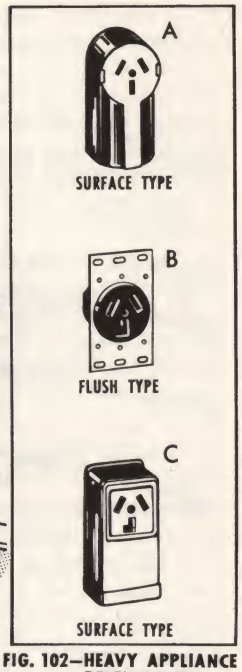


FIG. 102—HEAVY APPLIANCE RECEPTACLES

INDIVIDUAL CIRCUITS REQUIRED. Major appliances such as the electric range, water heater, clothes dryer, etc., operate on 230 volt service and require individual circuits. The wiring of major appliances presents no problem if the service entrance switch has adequate capacity. (See Page 11.) Wards recommends a 100 ampere service as a minimum. Pay close attention to grounding requirements, as detailed on Page 31.

ELECTRIC RANGES. Most electric ranges operate on 115-230 volts. (See Page 3 for explanation of voltage differences.) On higher heats, burners or elements are on 230 volts, for lower heats—115 volts. A 3-wire circuit is required; use either a 3-wire cable or 3 wires in conduit. Fig.101 shows how conduit or cable is run between the fuse box or circuit breaker cabinet and the range receptacle. Use a heavy duty 50 ampere, 250 volt receptable. Install either a flush-mounted type (Fig. 102-B), or a surface-mounted unit (Fig. 102-A or 102-C) in the wall at the point where range is to be located.

Use either No. 6 or No. 8 wires or cable, depending on wattage of range. Heavier No. 6 wire is preferred. Check local codes for acceptable wire or cable to use. *If conduit is used, be sure neutral wire is white.* Service entrance cable may be used for hookup from fuse box to receptacle; the neutral wire is then connected to the neutral terminal of the receptacle.

The range is connected to a 250 volt—50 ampere—3-wire pigtail cord (Fig. 101-insert) which plugs into range receptacle. To disconnect range, pull out plug. Ground frame of the range range to the neutral terminal (Fig. 101-insert), making certain that the neutral wire of the pigtail cord runs to this terminal.

ELECTRIC WATER HEATERS. There are a number of methods used in wiring water heaters. The choice of method and type of water heater (single or double element) must be determined by consulting the local utility company or the REA. In many localities the utility company supplies power for water heaters at a reduced rate for off-peak service. In this case, the heater may be on a separate meter and a time switch assembly (installed by the utility company) to permit use of electricity by heater only during specified night hours when the demand for current is the lowest. The single element operation during the day changes to double element heating during off-peak use. By using a 52-to-82 gallon tank, enough water can usually be stored to last until the following day. The power consumed by water heaters ranges from 1500 to 4500 watts, and higher, for 230 volts only. Unlike electric ranges, they are never combination 115/230 volts; hence, only two wires, both "hot" (usually 10 or 12 ga.) are needed. A neutral or white wire (unless painted black at both ends to indicate it is "hot") should not be used for water heaters.

WATER HEATER DISCONNECT. A means for disconnecting the water heater is required. Use a modern fuse type combination entrance switch (Page 10), which permits the circuit to be disconnected by removing the pull-out block serving the heater. If circuit breaker entrance switch is used, provide a special 30-amp, 2-pole breaker for heater; otherwise, a separate disconnect switch is required.

ELECTRIC CLOTHES DRYER. Wiring for a 230 volt clothes dryer can be 3-wire cable, 3 wires in a conduit, or service entrance cable. Check local utility company requirements. Usually No. 10 or heavier wire is used, depending upon wattage of dryer. As in the case of water heaters, a circuit disconnect (pull-out cartridge fuse block, circuit breaker or a separate disconnect switch) must be provided. The dryer frame must be grounded. Fig. 101 shows installation of a pigtail dryer cord which is similar in appearance to the heavier range cord. Installation for a high-speed dryer is about the same as for an electric range, as described above. (See Fig. 101-insert.)

AIR CONDITIONING WIRING. If the addition of a central air conditioning system is planned, it is important to consult the local utility company to determine if power for the added electric load is available, and to be sure that service wires of adequate capacity will be installed. An air conditioning installation requires 3-wire, 230 volt wiring and, at least, a 100 ampere service entrance. The air conditioning equipment selected should be suitable for the phase and cycle of the power available.

SELECT Electric Motors

Electric motors—fractional and those rated over one horsepower—are used for a wide variety of applications; on modern farms electric motors save time and cut operating costs. They use electricity only in proportion to the power they are called upon to deliver. A one-horsepower motor, at average electrical rates, will work for a few cents an hour. Running continuously, it will deliver energy equivalent to that expended by several men. Motors are low in initial cost and require little maintenance. With reasonable care they will give efficient service for many years.

STARTING AND OVERLOAD CAPACITIES

All motors have a built-in overload capacity which enables them to develop for a short period only, the extra power needed for initial starting load requirements. They will also safely handle momentary emergency overloads while in full operation, providing the overload is not continuous. For example, when starting a fully loaded machine or when a knot is encountered while sawing lumber, the necessary extra power is developed without the use of complex clutch and gearing mechanisms. A good motor will develop from 1½ to 4 times its rated capacity for a short period. No motor, however, should be deliberately overloaded continuously as it will burn out unless some type of overload protection is provided. If a motor is protected with a time-lag fuse or built-in overload protector, it will shut off automatically if the overload continues.

SELECTING WIRE SIZE FOR MOTORS

Check nameplate on motor for rated horsepower, then measure the distance from motor to fuse box or meter and consult Table IV, Page 38 for proper size wire to use.

In general, there are two good rules to follow:

1. *Never skimp on wire size.*
2. *For motors ¾ HP or above use 230 volt, 3-wire service, if available, and if motor is so rated.*

The size of wire used must be big enough to handle rated capacity of motor, plus extra amperes required for starting and the handling of temporary overloads. The distance from motor to meter must be considered in selecting the wire size, to avoid voltage drop which causes overheating and loss of power.

ELECTRIC MOTOR SELECTION. The electric motor should be selected according to the type of equipment it is to operate and the amount of power that will be needed for continuous operation. It is better to buy a motor with a slightly higher rating than is actually needed, as an overloaded motor wastes power and will burn out.

SPLIT-PHASE MOTOR. For applications requiring easy starting loads, or where maximum load is applied after the motor has attained full speed, a split-phase motor is ideal. Use for operating light power tools, washing machines, some small paint sprayers, fans, etc., which require a motor ½ H.P. or smaller.

IMPORTANT: *Do not use for any hard starting machine such as a compressor, pump, etc.*

CAPACITOR MOTOR. For heavier power tools, larger paint sprayers, stokers, etc., capacitor motors from ⅓ to 1 HP do a fine job. These units are similar in construction to split-phase motors, except they are equipped with a condensor which aids in the starting of heavier loads and reduces current requirements for starting. Capacitor motors are suitable for medium-to-hard-starting loads such as compressors and production equipment.

HEAVY DUTY CAPACITOR MOTOR. Deep well pumps, compressors, grinders and "work horse" farm machinery require heavy-duty motors. A heavy duty capacitor motor handles general purpose heavy work in severest climates. This type has superior starting ability which enables almost any hard-to-start machine to "break loose."

BELTS AND PULLEYS

Keep belts reasonably slack to avoid motor strain, and excessive bearing and belt wear. Select pulley combinations for speeds wanted from Table V on Page 38. Machine pulley speeds are based on motor speed of 1725 RPM.

REPLACEMENT MOTORS AVAILABLE. Wards maintains large stocks of replacement motors for a wide variety of purposes. (See Fig. 103.) Split-phase motors operate furnace blowers and attic or window fans, oil burners and a variety of power tools. Other capacitor motors and heavy-duty capacitor motors are for pumps, compressors and appliances, etc. Installation of replacement motors is simple . . . just remove old motor and install a new Wards model with just a few tools. Select motor from catalog or at nearest Wards retail store.

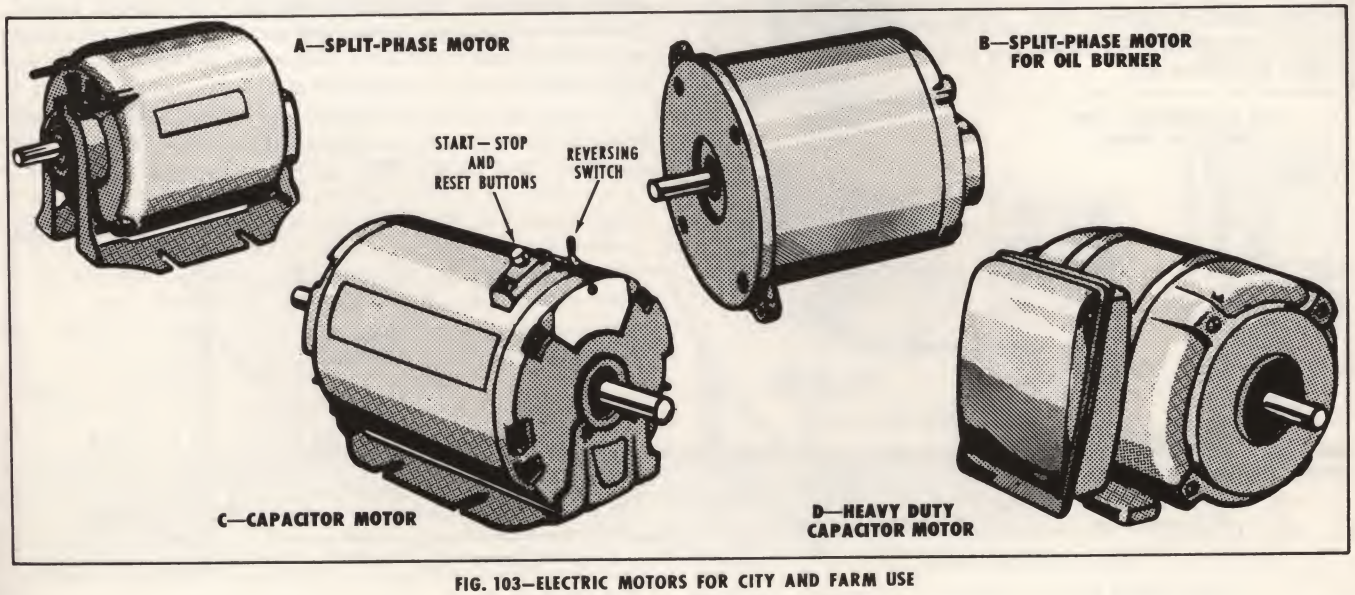


FIG. 103—ELECTRIC MOTORS FOR CITY AND FARM USE

HOW TO Install Yard and Patio Lighting

. . . ORNAMENTAL AND PRACTICAL USES OF LIGHTING FOR YARD AND PATIO

The growing popularity of outdoor living has made the yard and patio an increasingly important center of American family life. Outside living can be made far more enjoyable when lighting and weatherproof outlets are provided for radio and television sets, fans, etc.

OUTSIDE LIGHTING FIXTURES. Page 36 of this booklet illustrates a variety of outdoor lighting fixtures sold by Wards. The back cover also pictures outdoor lighting. The attractive post lantern (Fig. 107) is decorative, but also provides illumination for the driveway, sidewalk and front yard. Floodlights can be used for recreational activities and to provide security after dark. Spotlights accent the summer garden or holiday decorations.

GROUNDED WEATHERPROOF OUTLETS. Power is supplied to outdoor cooking appliances, lighting fixtures and garden tools from flush-mounted weatherproof outlets located on the buildings (Fig. 104-B). Lawn mowers, spike lights, heating tape for hotbeds or snow melting may be connected to conveniently located weatherproof surface-mounted outlets on posts or conduit stubbed up through the ground. (See Fig. 107.)

SEPARATE CIRCUITS FOR OUTDOOR WIRING. When outdoor wiring is installed, it may be added to an existing circuit, provided it is not overloaded. For heavy loads, install outdoor wiring on one or more separate circuits. It is suggested that circuits for outdoor lighting be not less than 115 volt, 20-ampere capacity. If outdoor electric cooking is anticipated, it may be necessary to install a 230 volt circuit, depending upon the type of equipment to be used. All outlets should be of the grounded type, as shown in Fig. 95, Page 31.

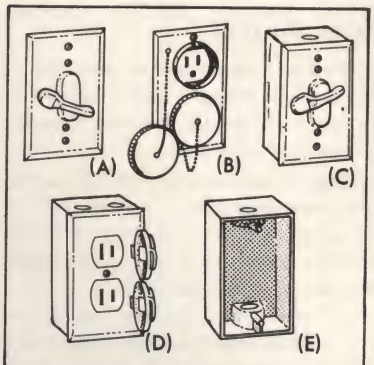


FIG. 104—MATERIALS FOR OUTDOOR WIRING

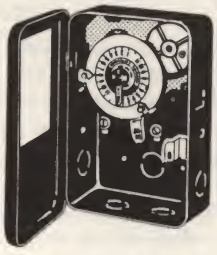


FIG. 105—ELECTRIC TIME SWITCH

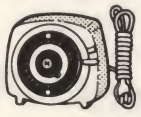


FIG. 106—PORTABLE TIME SWITCH

UNDERGROUND OR OVERHEAD WIRING? Use of underground (Page 25) or overhead (Page 24) wiring will depend upon the individual application. Generally, underground wiring is neater and permits a more flexible installation. However, if ground is too rocky to dig a trench, or when elevated lighting is desired, overhead wiring may be more practical.

CONTROL LIGHTING FROM INSIDE. For convenience and safety, outdoor lighting should be controlled by switches in the house, or from a sheltered area such as the garage. Also, an additional switch in the bedroom permits quick investigation of unusual outside sounds at night. For outside control, use a weatherproof switch box installed in a convenient location. Information on 3-way and 4-way switches which provide multi-switchpoint control appears on Page 19.

TIME SWITCH TURNS LIGHTS ON—OFF. An ideal device for use with yard lights and post lanterns is Wards electric time switch (Fig. 105) which turns lights on and off automatically. By a simple setting of a dial on the time switch, the post lantern provides light after dark, then turns off by itself at the selected time. A portable, automatic time switch (Fig. 106) can be used for night time control of interior lighting. This is particularly desirable when the house is unoccupied over weekends or during vacations.

POST LANTERN INSTALLATION. Wiring and installation of a post lantern is a reasonably easy project for one man. Before ordering materials, check local code to determine if plastic-covered cable, lead covered cable or trench wire is permitted. First, dig a hole 3 feet deep for post and extend a trench for wire leading to power source. Fig. 107 shows how cable is inserted inside of lantern post and connected to lantern wires; either solder the connections, or use solderless connectors. (See Page 7.)

Next, place and plumb the lantern post in dug hole and support it on three sides with braces or guy wires. Lay cable from post into trench, allowing slack for expansion and contraction. Use wire in one piece between house and lamp; splices should not be below ground level. Fill in the trench, then mix concrete and pour into post hole to within one or two inches above grade level. Guy wires or braces should be left in place until concrete has set.

It is recommended that the post lantern should be controlled by an indoor manual wall switch. For greater convenience an automatic time switch (Fig. 105) may be used.

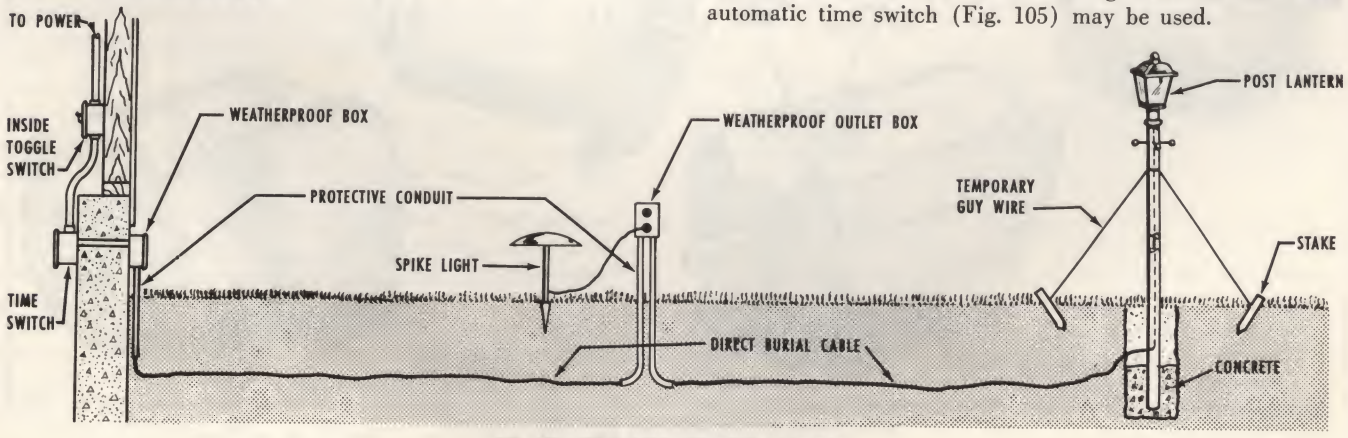


FIG. 107—INSTALLING THE POST LANTERN

Electric Heating Tape .....Electric Heating

PREVENT COSTLY WINTER FREEZE-UPS

USES OF CABLE AND TAPE. A practical method of avoiding frozen water pipes is to protect them with electric cable or tape. It should be wrapped around exposed water pipes (Fig. 108-A) to prevent them from freezing. Gutters and downspouts may also be protected with the same type cable. Lay cable in gutters, drop it into downspout and fasten to roof with special clips. (See Fig. 109.) Adequate winter roof drainage prevents water damage to a building's interior caused by back up of water under roof.

Cable buried in concrete steps (Fig. 108-B), sidewalks and driveways melts snow electrically. On farms, heating cable in floors of sow farrows (Fig. 108-C) and chicken pens helps produce healthy hogs and poultry during winter months. Fig. 108-D shows cable installed in a hotbed to give plants an early start.

USE 115 OR 230 VOLT CABLE. Wards sells flat heating tape (Fig. (110) which plugs into any outlet or special thermostat. Heating cable up to 60 ft. in lengths (440 watts) can be operated on 115 volts; cable up to 120 ft. long requires 230 volt current.

THERMOSTAT CONTROLS CABLE TEMPERATURE. The heating cable temperature may be automatically controlled by means of an adjustable thermostat. (See Fig. 110-B.) Uniform heat is delivered to the required areas and current costs are kept to a minimum. Heating tape with a built-in thermostat (Fig. 110-C) turns on automatically when the temperature reaches freezing, and over-heating is prevented. The use of a thermostat is particularly recommended when cable is used for water pipe protection. In the absence of a thermostat, if plug receptacle is used, heating cable should be controlled by a manual switch to permit turning it on or off, as desired.

WATERPROOF CONNECTIONS NEEDED. Unless area to be heated by cable is near an inside house outlet, a weatherproof outside outlet will be needed. Waterproof connections between lead wires and power source are important; also, use approved, exterior type junction boxes, fittings and snug bushings. All connections should be protected with insulating tape. Installation instructions are furnished with all Wards heating cable.

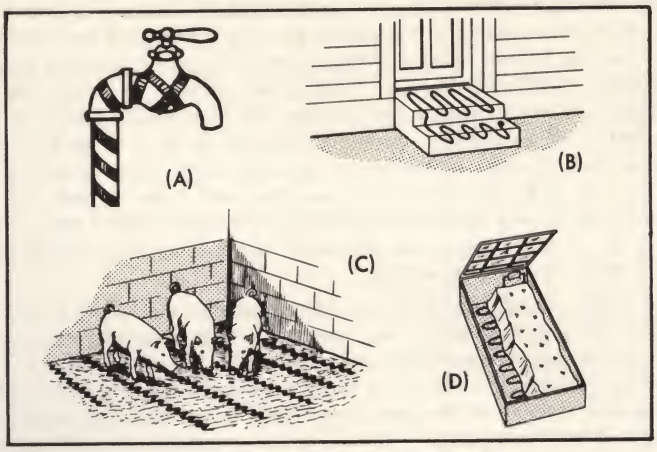


FIG. 108—HEATING TAPE APPLICATIONS

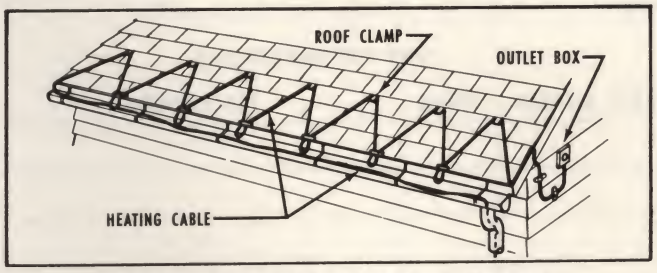


FIG. 109—TAPE USED FOR WINTER ROOF DRAINAGE

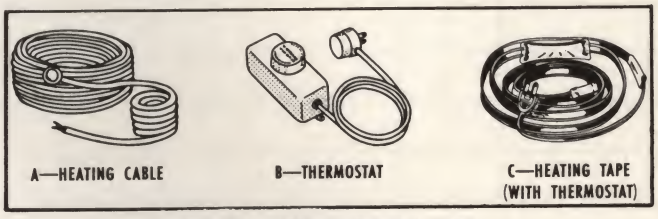


FIG. 110—TYPES OF HEATING TAPE

ELECTRIC HEAT PROVIDES MODERN HOME COMFORT

Home heating by electricity offers many advantages. It is clean, silent and flameless. Uniform temperatures are maintained automatically, and space is not required for fuel storage or a heating plant. Many electric utility companies have put into effect attractive power rates which include cooking, water heating and lighting at the same low rate as for home heating.

The entire home can be heated electrically, or just one room or an enclosed porch. Several heating units or a complete system should always be wired for 230 volts, although small single units are often used with 115 volt current. It is recommended that the home craftsman confine the electric heater installation to 115 volt supplementary heating units. Wards auxiliary heating panels, fan-type electric wall heaters and radiant wall insert heaters, each of which are illustrated in Fig. 111, are all equipped with built-in thermostat controls.

Consult the utility company to determine if your building will be approved for electric heating. You should familiarize yourself with requirements for building insulation, rates and other conditions. For circuits not over 15 amp. No. 14 wire is acceptable, but it is recommended that the wire size not be smaller than No. 12.

Write to Wards Customer Engineering Department for Heating & Air Conditioning Information Form No. 26702 if an estimate for electric heating equipment is desired, or inquire at your nearest Wards retail or catalog store. Most Wards stores are prepared to make complete installations on a contract basis.

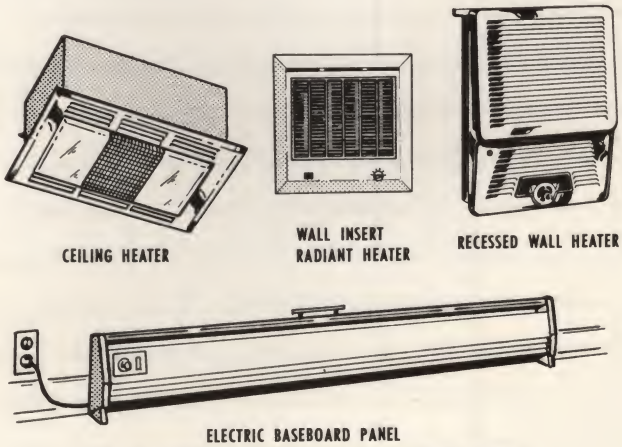


FIG. 111—SUPPLEMENTARY ELECTRIC HEATING UNITS

For your convenience —

HOW TO USE SKETCH PLAN. On the opposite page, space is provided for making a simple pencil sketch of the wiring job. The sketch does not have to be as refined as the layouts shown on Pages 8 and 9; however, it would be advisable to study the electrical symbols on Page 9 and use them to indicate the location of all light and plug-in outlets and switches. The layout sheet is divided into squares so that it will be easier to make the drawing of the room or floor plans of the home, barn or other outbuilding to accurate scale. Each square can represent 6 in., 1 ft., 2 ft., etc., depending upon the area to be covered. Use a soft lead pencil (No. 1 or 2 pencils are suitable) so that lines will be plainly seen and be easy to erase if changes are necessary. Use a metal rule, folding rule or yardstick when taking measurements.

LIST YOUR MATERIALS. After you have prepared the wiring installation layout sketch showing the number and types of wiring components to be used, make a list of materials needed for the job. Use the sketch plan as a reminder when making your list of materials in the space provided below to be certain that all items are ordered at the same time. Copy these materials on a Wards order blank, if purchasing by direct mail, or on a separate sheet if materials will be purchased from a Wards store. Remember—all Wards wiring supplies are UL-approved or meet REA specifications where required.

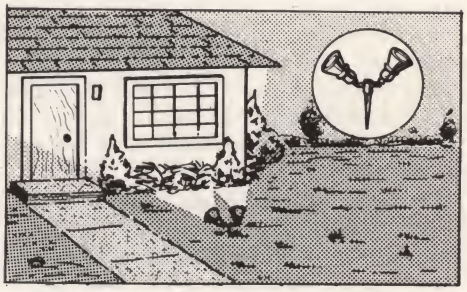
LIST OF MATERIALS

WARDS NUMBER	QUAN.	DESCRIPTION	PRICE

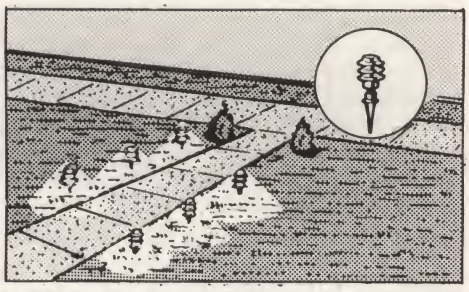
Consider These Outdoor Lighting Suggestions

Outdoor lighting fixtures serve a dual role; they beautify the yard and grounds, and they provide light for after dark safety and entertaining. Select your outdoor lighting needs from Wards catalog or nearest Wards retail or catalog store.

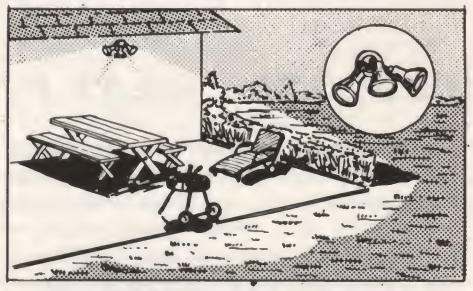
Information on installing outdoor wiring appears on Page 34.



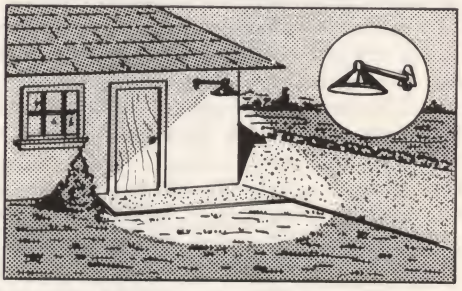
TWIN SPIKE LIGHT—Use for contrast lighting of bushes and trees, and for dramatic emphasis of landscape.



SPIKE WALK LIGHT—Enhance the garden at night by placing these decorative units along paths or walks.

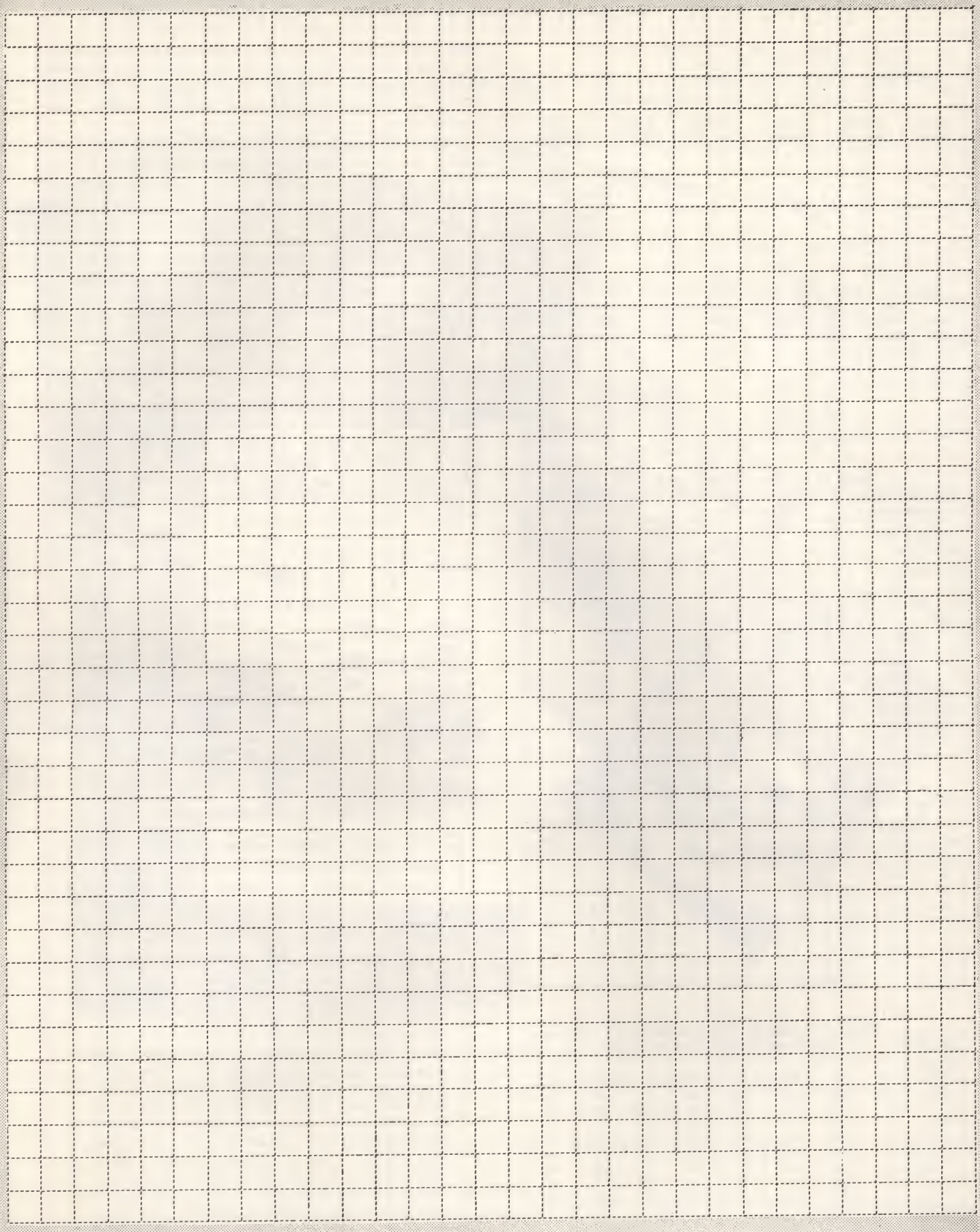


WEATHERPROOF SWIVEL FLOODLIGHTS — This cluster of lights is mounted overhead for recreation on lawn, or to light shadowy areas outside the house.



YARD LIGHT. This overhead light provides after dark security from prowlers and illuminates remote service areas.

PLANNING CHART



SCALE:_____ SQ. = _____FT.

USEFUL WIRING TABLES

TABLE I — CONDUIT SIZE AND AMPERE CAPACITY OF WIRES IN CONDUIT

Number of Wires (1 to 9) to be Installed in Conduit. (Exact Number Will Vary According to Local Code.)					
WIRE SIZE	AMPERE CAPACITY	½-INCH CONDUIT	¾-INCH CONDUIT	1-INCH CONDUIT	1¼-INCH CONDUIT
14	15	4	6	9	9
12	20	3	5	8	9
10	25	1	4	7	9
8	35	1	3	4	7
6	45	1	1	3	4
4	60	1	1	1	3
2	95	1	1	1	3

TABLE II — WIRE SIZES AND CAPACITIES FOR 115 VOLTS*

WIRE SIZE	MAX. FUSE AMPS.	DISTANCE (FEET) ONE WAY FOR AMPS AND WATTS					
		5A 575W	10A 115W	15A 115W	20A 2300W	25A 2875W	35A 4025W
14	15	90	45	30			
12	20	140	70	47	35		
10	25	220	110	75	60	45	
8	35	360	175	125	90	75	55
6	45	560	280	190	150	120	85

* *See Voltage Explanation on Page 3.*

TABLE III — FARM WIRING SELECTION

OPERATING LOAD OF BUILDING	DISTANCE: YARDPOLE TO BUILDING	RECOMMENDED WIRE SIZE TO USE
UP TO 3KW	UP TO 50 FEET	10 GA.
	OVER 50 FEET	8 GA.
3 KW-5 KW	UP TO 50 FEET	10 GA.
	50 TO 125 FEET	8 GA.
	125 TO 250 FEET	6 GA.
	OVER 250 FEET	4 GA.
5 KW-7 KW	UP TO 50 FEET	10 GA.
	50 TO 125 FEET	8 GA.
	125 TO 200 FEET	6 GA.
	200 TO 300 FEET	4 GA.
	OVER 300 FEET	2 GA.
7 KW-9 KW	UP TO 50 FEET	10 GA.
	50 TO 100 FEET	8 GA.
	100 TO 150 FEET	6 GA.
	150 TO 250 FEET	4 GA.
	250 TO 350 FEET	2 GA.

TABLE IV — WIRE SIZES FOR MOTORS

H.P.	DISTANCE FROM MOTOR TO FUSE BOX OR METER							
	0 TO 50 FT.		50 TO 100 FT.		100 TO 150 FT.		150 TO 200 FT.	
	115V	230V	115V	230V	115V	230V	115V	230V
	WIRE GAUGE REQUIRED							
¼	14	—	12	—	12	—	10	—
⅓	14	14	12	14	12	14	10	14
½	14	14	10	14	10	14	8	14
¾	12	14	10	14	8	14	6	12
1	12	14	8	14	6	12	6	12
1½	10	12	8	12	6	8	4	6
3	8	14	4	10	4	8	2	8
5	6	12	2	8	0	6	0	6

TABLE V — MOTOR PULLEY SELECTION *

MOTOR PULLEY SIZE	PULLEY ON MACHINE: SIZE IN INCHES:							
	1½	2	2½	3	4	5	6	8
1½ in.	1725	1290	1035	860	645	515	430	320
2 in.	....	1725	1380	1150	860	690	575	430
2½ in.	....	2150	1725	1435	1075	860	715	540
3 in.	....	2580	2070	1725	1290	1035	860	645
4 in.	....	3450	2760	2300	1725	1380	1150	860
5 in.	....	4300	3450	2875	2155	1725	1435	1075
6 in.	....	5175	4140	3450	2585	2070	1725	1290
8 in.	....	6900	5520	4600	3450	2760	2300	1725

* *Machine Speeds Based on Motor Speeds of 1725 RPM*

—TESTING APPLIANCES—

APPLIANCE TESTING. To construct a homemade tester for checking electrical appliances and cords, connect two dry cell batteries to doorbell or buzzer (Fig. 112-A) with lead wires. For convenience in carrying, tape batteries together with friction tape.

A neon bulb circuit tester (Fig. 112-B) is inexpensive and easy to use. Instructions which come with it explain how to test circuits, switches, outlets, sockets, fuses, etc., connected to any 115 volt power source.

TESTING APPLIANCE CORDS. If an appliance fails to operate, the trouble may be traced to the house circuit, appliance cord or to the appliance itself. If other appliances or lamps operate properly when plugged into the same outlet, house current is adequate. To test appliance cord, first disconnect it from the appliance. Next, put one tester lead into one of the cord slots (See Fig. 113.) Touching either of the plug blades with the other lead wire should make the bell ring. Test both cord slots in the same manner. Cord is defective if the bell does not ring.

If cord and house current are sound, appliance has broken wire or bad element which must be repaired or replaced. To test appliance for shock hazard (current leak), touch one lead to metal frame of appliance. (See Fig. 114.) Touch other lead to cord plug blades—first one and then the other. If bell fails to ring, there is no apparent shock hazard. Never connect tester to outlet.

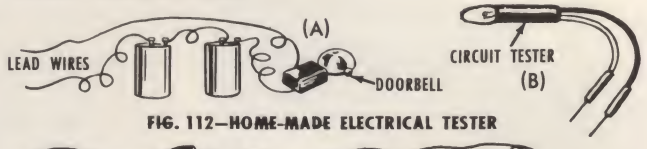


FIG. 112—HOME-MADE ELECTRICAL TESTER

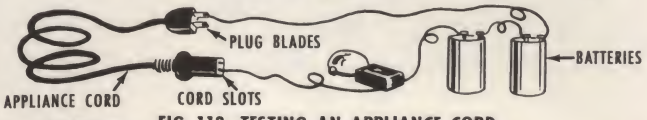


FIG. 113—TESTING AN APPLIANCE CORD

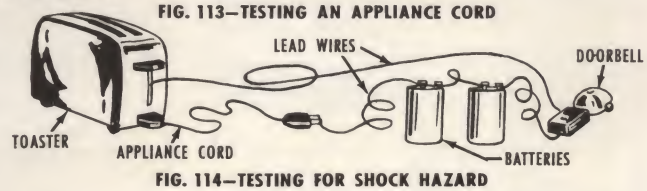


FIG. 114—TESTING FOR SHOCK HAZARD

TEST WIRING INSTALLATION

SIMPLE HOME-MADE TESTER. After wiring is installed, it should be tested before power is connected. To test a wiring installation, all that is needed is an ordinary doorbell and two dry cell batteries. (See Fig. 112-A). *Make sure that regular power is disconnected before testing.* After the wiring is installed, twist together temporarily all wires which will be spliced. At points where switch is to be installed, couple wires together just as if switch was in "on" position. Then, connect two cells in a series so a wire runs from the center terminal (positive) of one cell to the negative terminal of the other. Attach lead wires to the remaining terminals of the battery and hook across the wires of circuit to be tested. Touch doorbell wires across each pair of wires at outlet boxes; if wiring is all correct, bell will ring. For armored cable and conduit systems, check also for a continuous ground. At each outlet, connect doorbell between black wire and box. If bell doesn't ring, tighten all locknuts on connectors.

PERSONAL ESTIMATING SERVICE

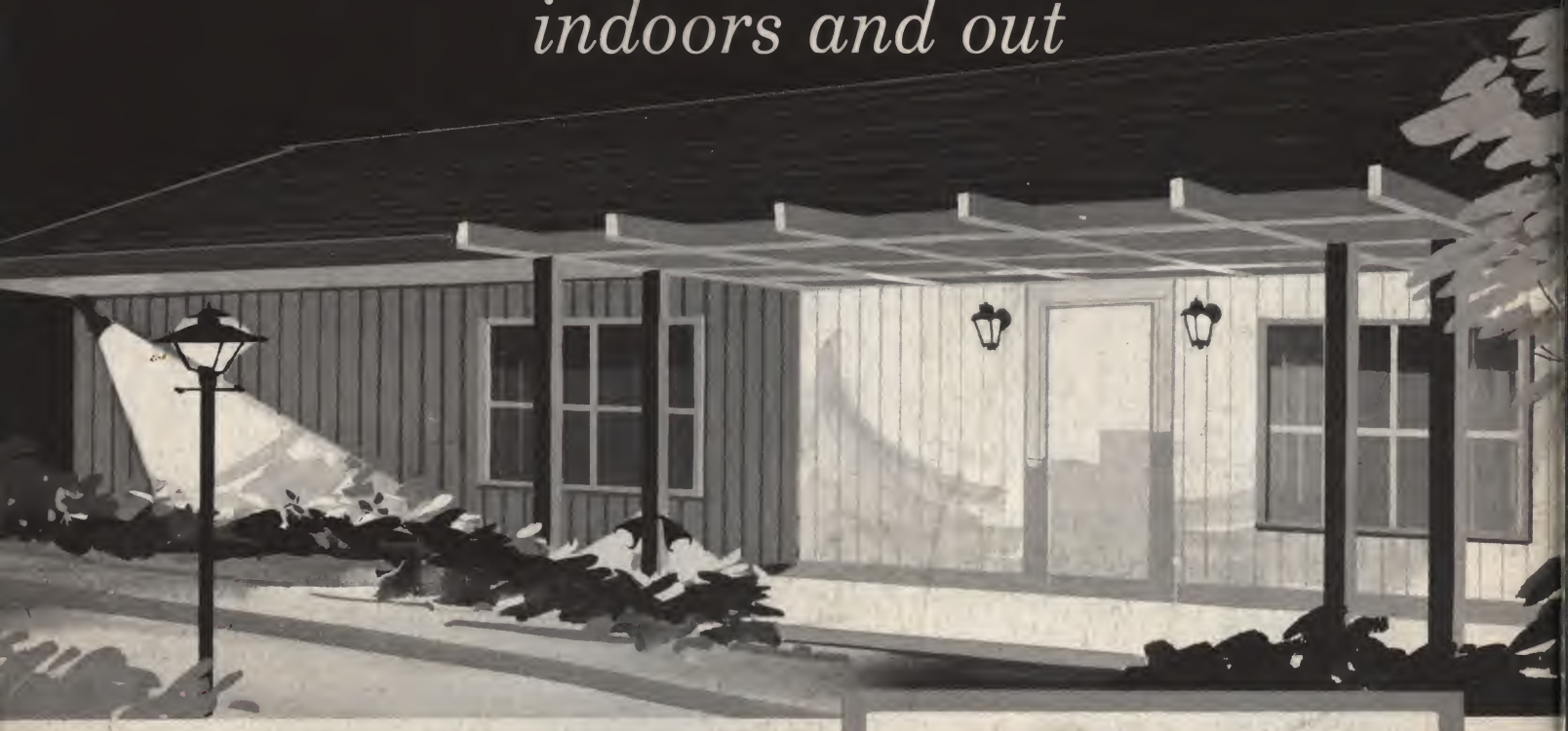
—for all jobs

Whether you are building new, modernizing, or replacing old equipment, Wards Customer Engineering Department is ready to serve you. Our technical staff will answer your questions, plan your job and prepare a cost estimate for equipment and materials needed . . . all without cost or obligation to you. Just fill in the proper information form and return it to us—we do the rest. Pick up forms at your Wards Retail or Catalog Store, or write to your Wards Mail Order House—see handy coupon in the catalog.

REQUEST FORMS BY NAME AND NUMBER:

HEATING AND AIR CONDITIONING	26702
PLUMBING AND WATER SYSTEMS	26703
CONVERSION BURNER AND STOKER	26705
LAWN SPRINKLER SYSTEM	26714
FURNACE OR BOILER REPLACEMENT	26794
FENCING	27366
KITCHEN PLANNING	27423
SWIMMING POOL	27698

MONTGOMERY WARD — *has everything you need to light and wire your home indoors and out*



- **SELECT** from an array of modern interior lighting fixtures, including chandeliers, pull-downs, double-glass ceiling fixtures.
- **BRIGHTEN** your kitchen or bathroom with modern styled incandescent or "glare-free" fluorescent lights.
- **OUTDOOR** lighting fixtures available include handsome post lanterns, practical yardlights and a variety of overhead and ground-level outside fixtures. Use with a complete line of weatherproof outlets and switches, also available for outdoor installation.
- **INSTALL** plastic-covered cable indoors, outdoors and underground, or select from a large variety of other types of approved wiring materials.
- **ENTRANCE** switch equipment, either fuse or circuit breaker types, should be selected on the basis of present and future power consumption. Switches of less than 100 amps. capacity are not recommended.
- **SAFETY** in the home or farm building can be assured if wiring system is adequate for the electric load, and when carefully placed switches are installed for multi-point lighting control.
- **REPLACE** old-fashioned doorbells with decorator-designed door chimes which are easily installed for use at both front door and back on the same system.
- **PREVENT** ice-clogged rain gutters, frozen water pipes, icy walks and driveways . . . provide warmth for plants growing in hotbeds with inexpensive electric heating tape.

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no delay; no strain on your budget!

With Wards convenient CHARG-all or "CHARG-all PLUS" Credit Plans, you can modernize and add to the value of your home now! There's no waiting! Wards "CHARG-all PLUS" Time Payment Plan — specially designed for "big ticket" merchandise — offers greater buying power and instant add-on privileges. Just say, "Charge it!"

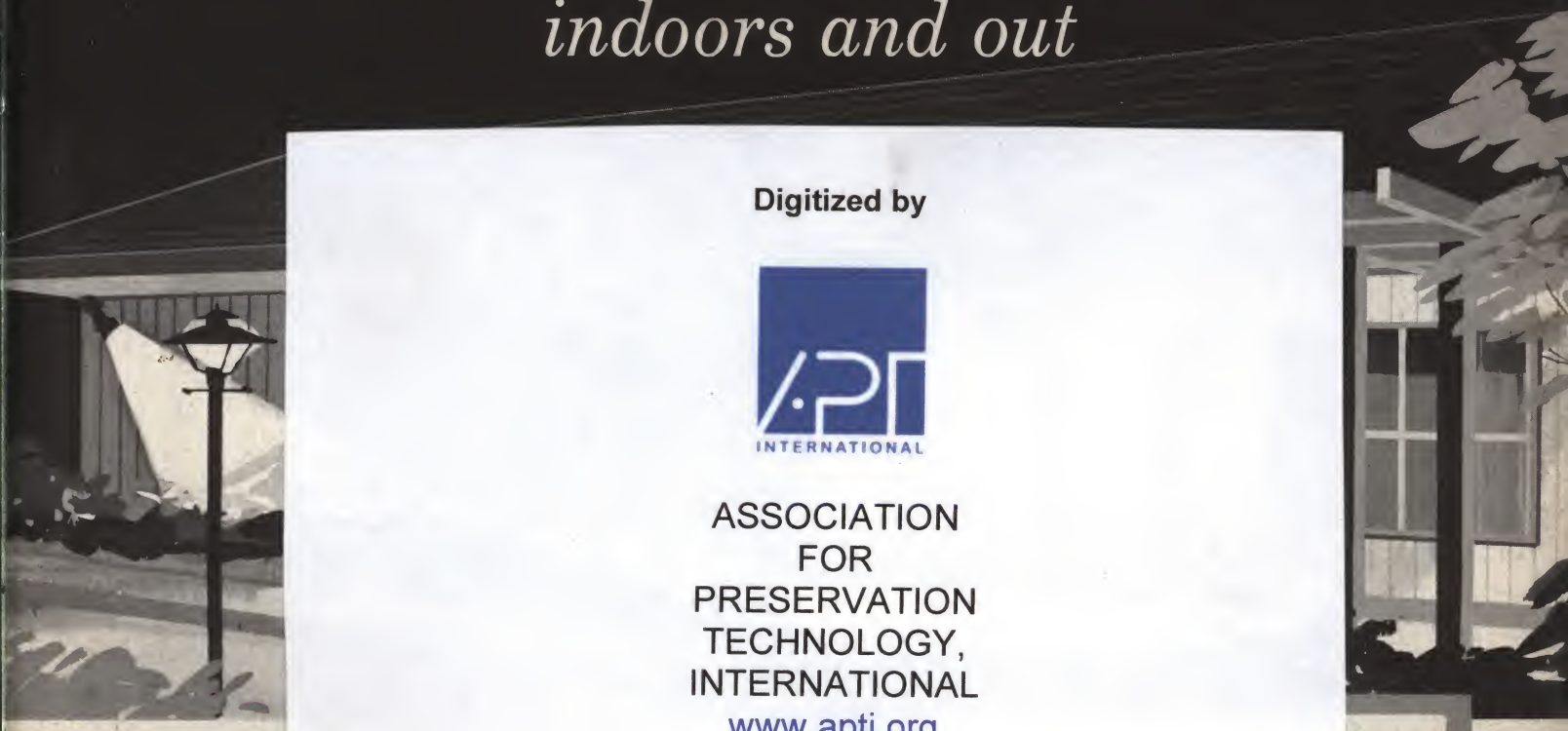
For complete information on Wards credit terms, visit, phone or write to the Wards store nearest your home, or, see the credit pages in Wards catalogs.

LISTED UNDER REEXAMINATION SERVICE UL OF UNDERWRITERS' LABORATORIES, INC.

Look for the UL label on all of your wiring materials. This means Underwriters' Laboratories has tested and approved the wiring or electrical equipment for minimum standards of safety and quality. All Wards wiring materials are UL-approved.

VISIT YOUR NEARBY CATALOG OR RETAIL STORE

MONTGOMERY WARD — *has everything you need to light and wire your home indoors and out*



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Look for the UL label on all of your wiring materials. This means Underwriters' Laboratories has tested and approved the wiring or electrical equipment for minimum standards of safety and quality. All Wards wiring materials are UL-approved.

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